

Global Precipitation Measurement (GPM) Mission Development Status

Goddard Space Flight Center



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Joint Seminar for CEE and ESS Departments
Center for Hydrometeorology and
Remote Sensing (CHRS)
University of California, Irvine

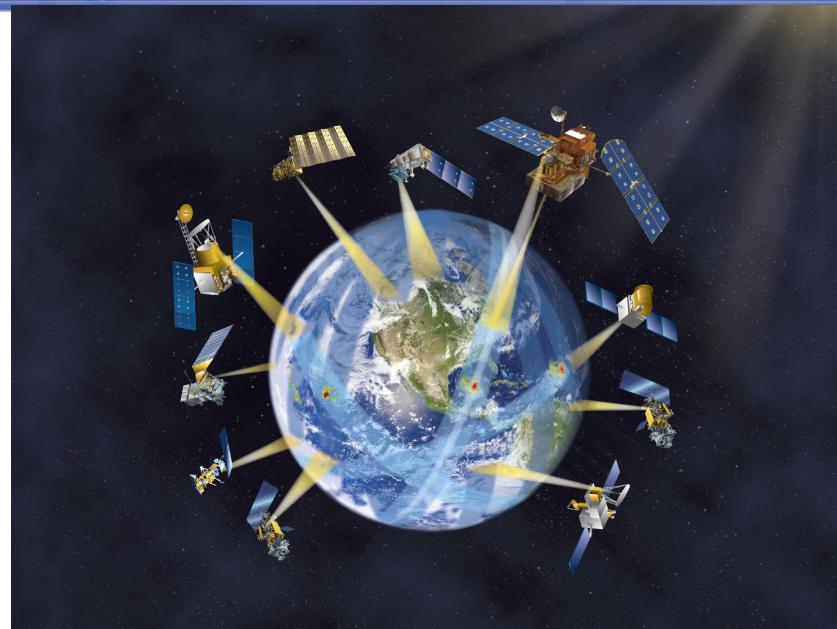
www.gpm.gsfc.nasa.gov

Mission Objective:

- Improve scientific understanding of the global water cycle and fresh water availability
- Improve the accuracy of precipitation forecasts
- Provide frequent and complete sampling of the Earth's precipitation

Mission Description (Class B, Category I):

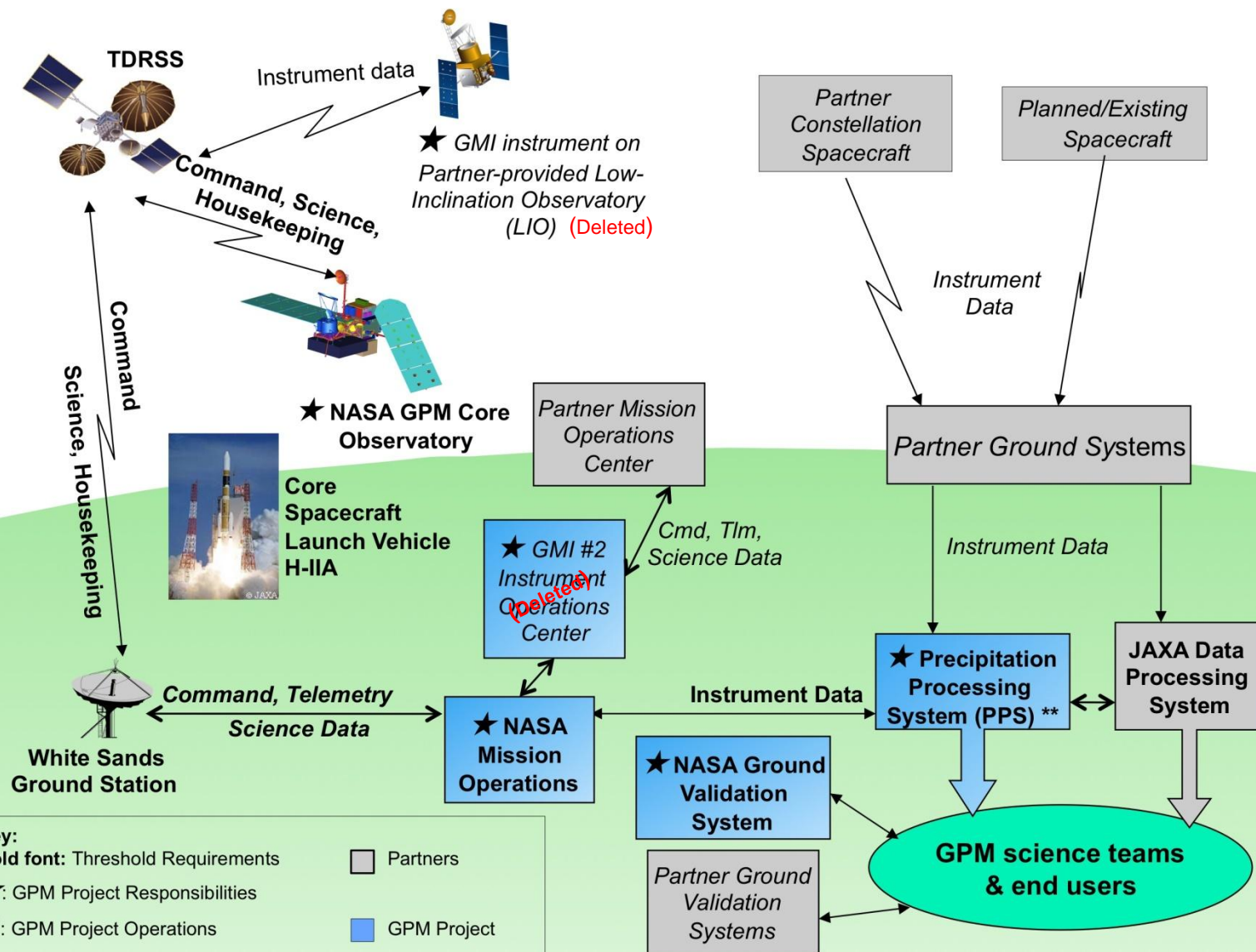
- **Constellation of spacecraft provide global precipitation measurement coverage**
 - NASA/JAXA Core spacecraft: Provides a microwave radiometer (GMI) and dual-frequency precipitation radar (DPR) to cross-calibrate entire constellation
 - 65° inclination, 400 km altitude
 - Launch July 2013 on HII-A
 - 3 year mission (5 year propellant)
 - Partner constellation spacecraft: Provided by JAXA, DoD, NOAA, other space agencies
- **Ground assets**
 - Precipitation Processing System: Data processing, archive, distribution for the entire constellation of spacecraft
 - Ground validation system: Uses world-wide network of ground-based measurements to validate space measurements and algorithms
 - Mission Operations Center for Core Spacecraft

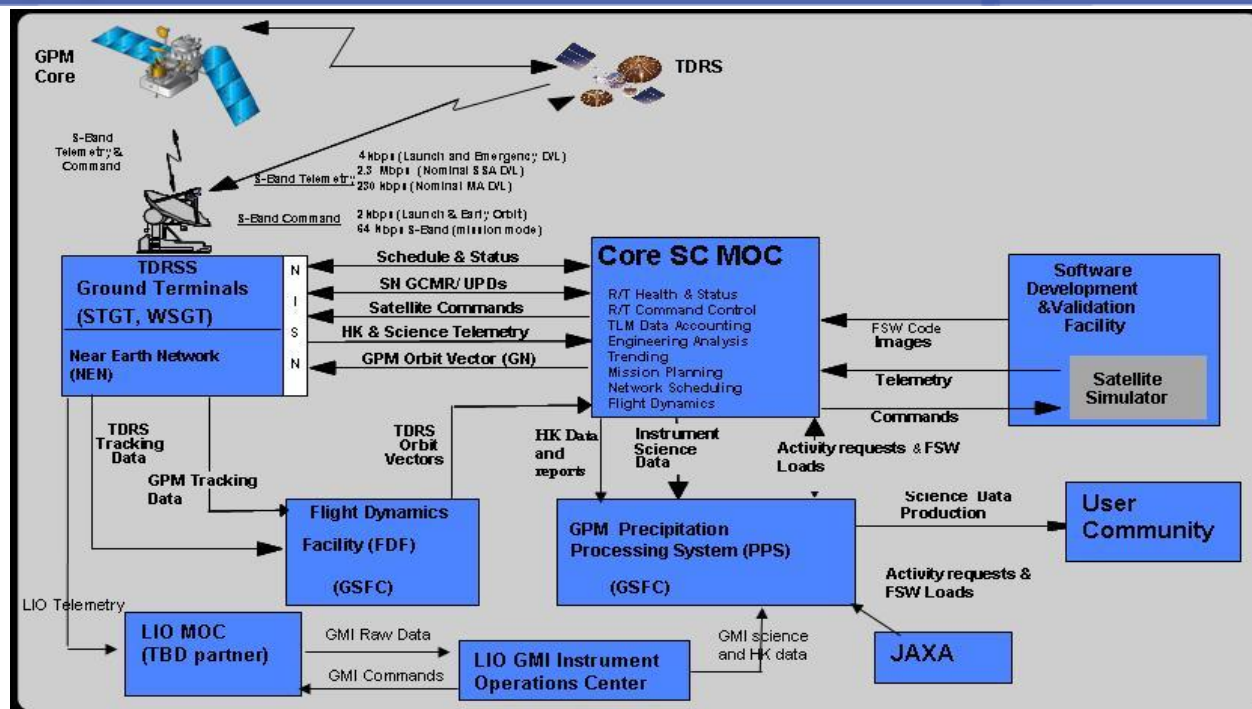


- **Partners**

- Japanese Aerospace and Exploration (JAXA)
 - DPR instruments for Core spacecraft
 - Launch service for Core spacecraft
- Other U.S. and international agencies
 - Data from radiometers (e.g. NPP, DOD DMSP, JAXA GCOM-W, Megha-Tropiques)
 - Ground validation partnerships
- Universities
 - Ground validation partnerships
 - Science team participation

Note: GMI #2 build and accommodated on the partner provided spacecraft was deleted on Feb 2011





Ground system supports:

- Radiometer precipitation products from GMI within 1 hour of observation
- Combined radar/radiometer swath products within 3 hours of observation

• Mission Operations Center (MOC)

- Largely automated, staffed 8x5
 - Instruments operate in survey mode, require very little commanding from ground
- Interfaces with Precipitation Processing System (PPS) to deliver:
 - 5-minute duration science instrument files
 - 5-minute duration housekeeping data files
 - Metadata associated with data processing and delivery
 - Ancillary data to support science product generation
- Interfaces with PPS to receive instrument commands and command requests as needed

• Precipitation Processing System (PPS)

- Creates higher-level science data products
- Delivers science data products to user community
- Provides interface to instrument science teams
- Delivers instrument commands, instrument team command requests to MOC

• LIO GMI Instrument Operations Center

- Interfaces with partner-provided MOC (TBD)
- Provides LIO GMI data to PPS

- **GPM Level-1 Requirements call for a Ground Validation System to**

- Support the PMM Science Team in pre-launch science algorithm development and post-launch product evaluation

- **The framework for the GPM-GVS is based on the GPM GVS Science Implementation Plan; it calls for 3 approaches to validation:**

- Surface: compare satellite data to US and International Networks of radars and gauges
- Vertical Column: physical process studies and field campaigns test and refine physically-based retrieval algorithms
- 4-Dimensional: field validation of satellite precipitation products integrated with meteorological and hydrological prediction models

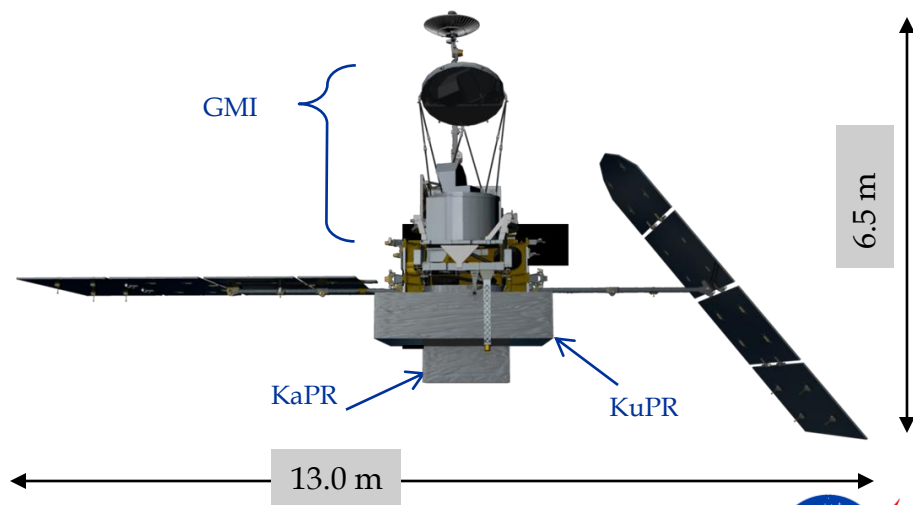
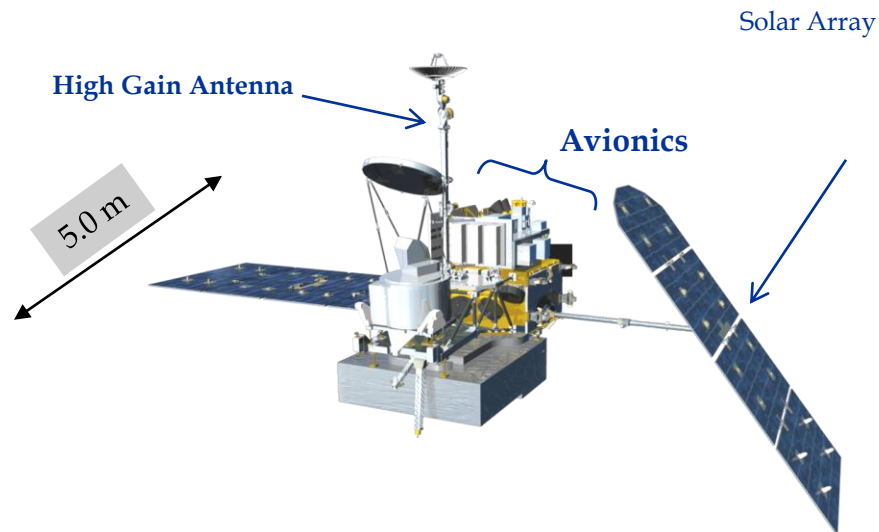
- **Ground validation program partnerships**

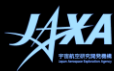
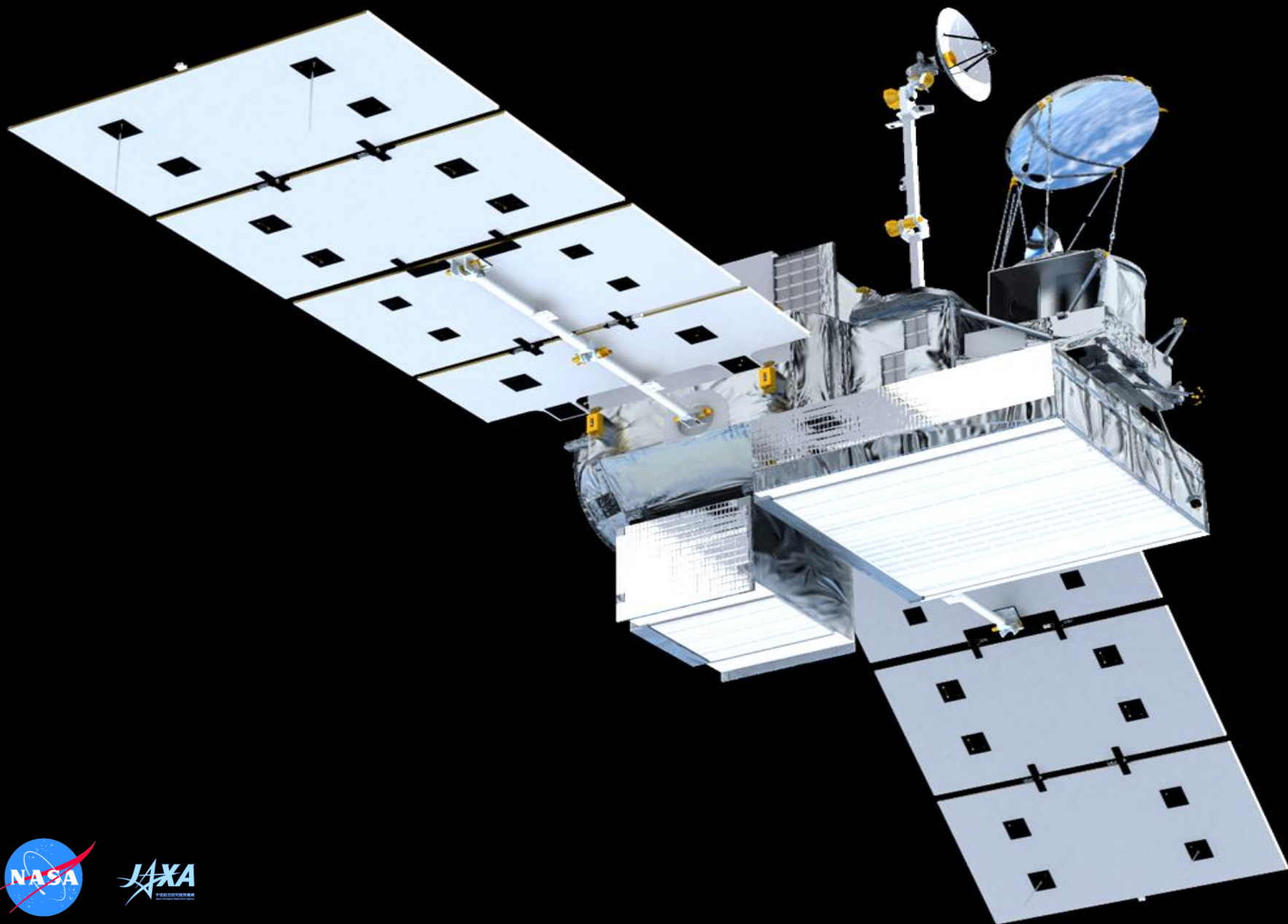
- Inter-agency and international partnerships improve the fidelity of ground validation
- Putting partnerships in place through workshops and working group meetings



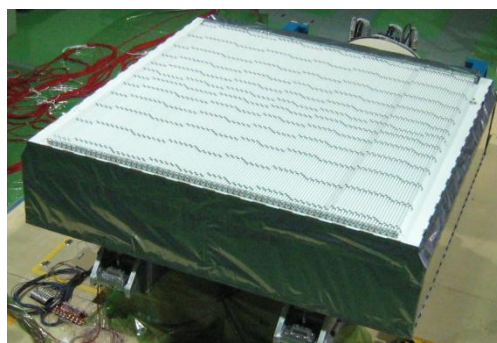
- **Five (5) field campaigns planned, starting in 2011**
- **~18 month intervals between campaigns**
- **Campaigns held in different climatic regimes**

- **Orbit: 407 km; 65 degree inclination**
- **3 year design life with 5 years propellant**
- **Controlled re-entry at end of operational life**
- **GPM Microwave Imager (GMI) : Conically Scanned Radiometer (Ball Aerospace)**
 - 10.6, 18.7, 23.8, 36.5, 89, 166 & 183 GHz
- **Dual-Frequency Precipitation Radar (DPR = KuPR + KaPR): JAXA**
 - 13.6, 35.5 GHz
- **Spacecraft bus: GSFC in-house design**
 - Aluminum and Composite
 - Modular, fully-redundant avionics
 - Steerable high-gain antenna on dual-hinged boom
 - Solar arrays track the sun
 - 12 thrusters (4 forward, 8 aft)
 - 240 Amp-hour Lithium Ion Battery
 - Size: 13.0m x 6.5m x 5.0m
 - Mass: 3850 kg
 - Power: ~1950W
 - Data Rate: ~300 Kbs (with onboard storage)





	KuPR (similar to TRMM PR)	KaPR (new for GPM)
Frequency	13.597 , 13.603 GHz	35.547 , 35.553 GHz
Horizontal Resolution	5.2 km (at nadir)	5.2 km (at nadir)
Swath Width	245 km	120 km
Scan period	0.7 sec	0.7 sec
Range Resolution	250 m	250 m / 500 m
Observation altitude	Up to 19 km	Up to 19 km
Minimum Detectable Rainfall Rate	0.5 mm/hr	0.2 mm/hr
Measurement Accuracy	within ± 1 dB	within ± 1 dB
Beam-matching Accuracy	< 1000 m	
Data Rate	< 109 kbps	< 81 kbps
Mass	< 472 kg	< 336kg
Power Consumption	< 446 W	< 344 W
Size	$2.5 \times 2.4 \times 0.6$ m	$1.2 \times 1.4 \times 0.7$ m



KuPR STM



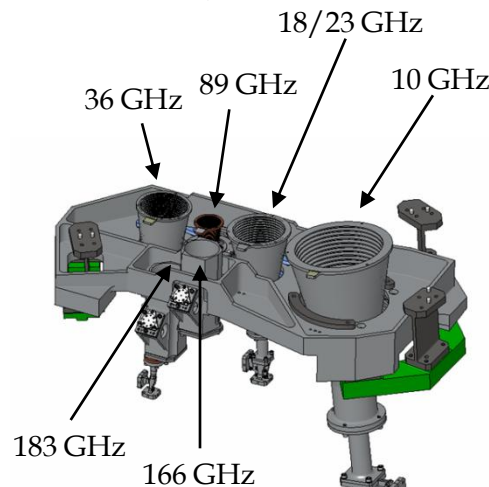
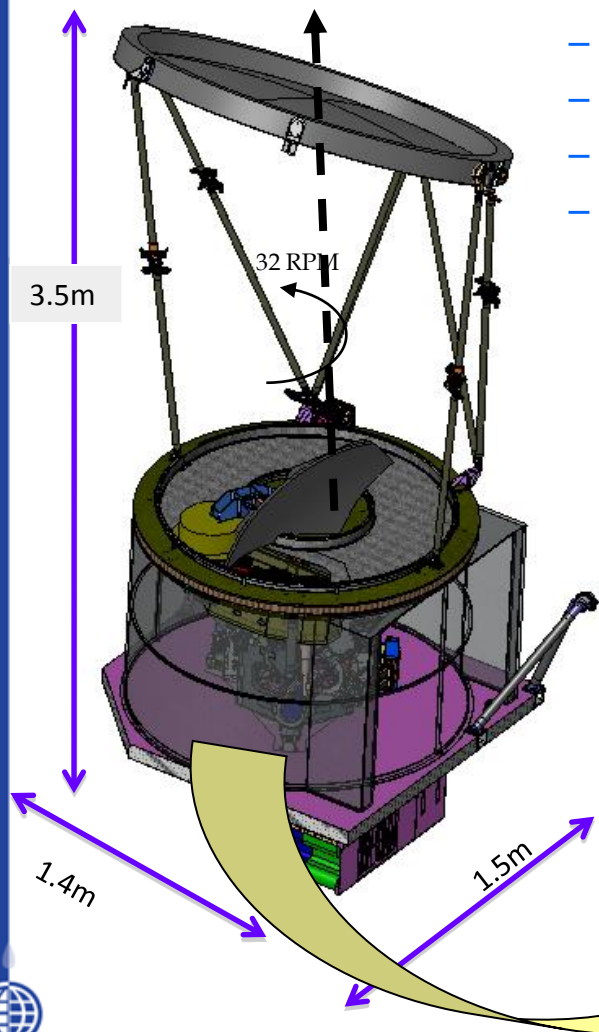
KaPR STM

- **GMI is a passive microwave radiometer with hot and cold calibration**

- 166 Kg, 162 W, 34.9 Kbs Science (4 Kbs Engineering data) 1.2 m diameter reflector

- **Conically scanned Main Reflector @ 32 RPM**

- Clear view enables high beam efficiency with low cross-pol coupling
 - Swath width 885 km
 - Resolution: 19.4km x 32.2km (10 GHz) – 4.4km x 7.3km (183 GHz)
 - Incorporates a 166/183 GHz sub reflector
 - Allows for single aperture
 - Enables critical frequencies to be located near the focal point while optimizing competing efficiency, beam width, and loss requirements



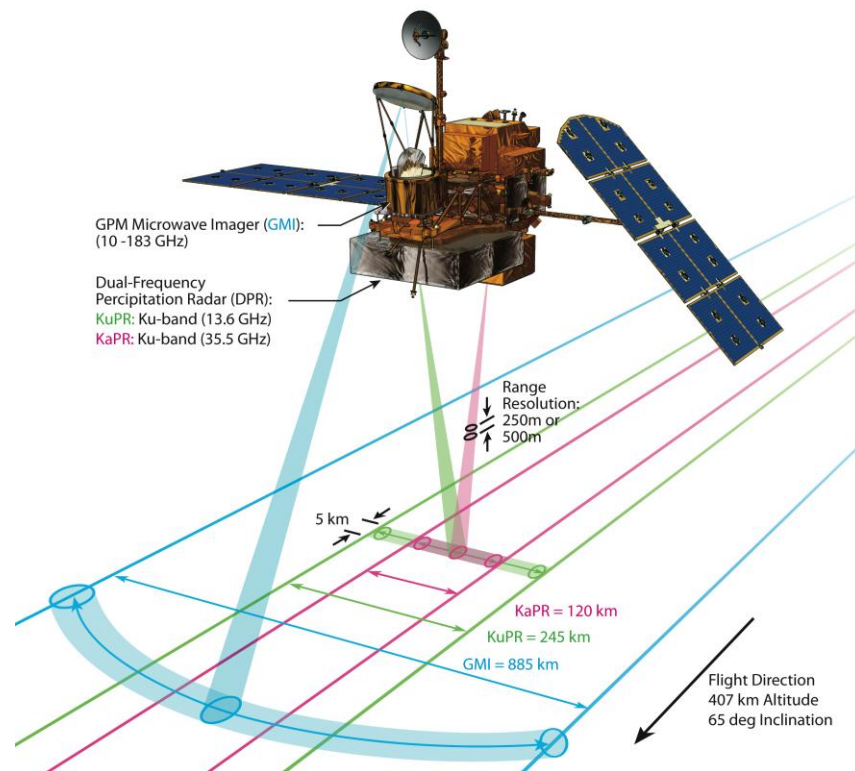
Frequencies	Polarizations
10.65 GHz	V/H
18.7 GHz	V/H
23.8 GHz	V
36.5 GHz	V/H
89 GHz	V/H
166 GHz	V/H
183 GHz	Va/Vb

GPM Microwave Imager (GMI) 10-183 GHz

- Passive microwave radiometer with hot and cold calibration
- 4-point calibration to serve as a radiometric reference for constellation radiometers
- High spatial resolution
- Improved light rain & snow detection
- Improved signals of solid precipitation over land (especially over snow-covered surfaces)

Dual Precipitation Radar (DPR) Ku-Ka band: 13.6 & 35.5 GHz

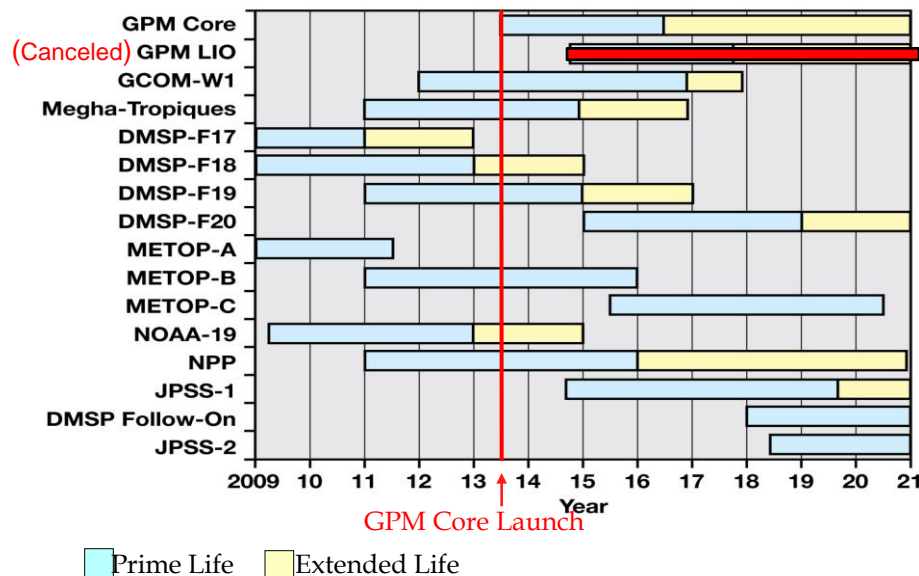
- KuPR similar to TRMM, KaPR added for GPM
- Provides three-dimensional measurements of cloud structure, precipitation particle size distribution (PSD) and precipitation intensity and distribution
- Increased sensitivity (~ 11 dBZ) for light rain and snow detection



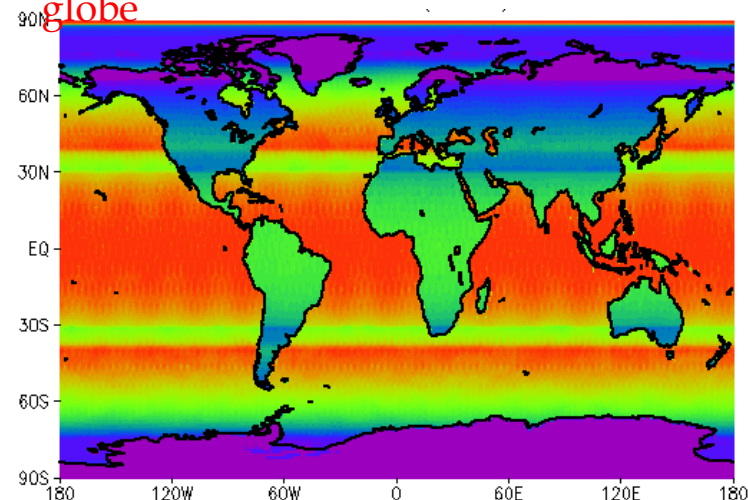
Combined Radar-Radiometer Cloud Database

- DPR & GMI together provide greater constraints on possible solutions to improve retrieval accuracy
- Improved a-priori cloud database for constellation Radiometer retrievals

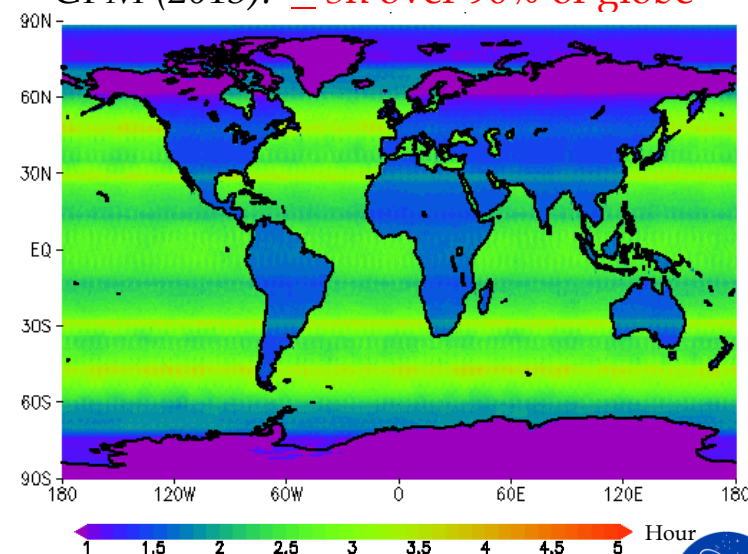
Baseline Constellation Schedule



Current Capability: $\leq 3\text{h}$ over 45% of globe



GPM (2015): $\leq 3\text{h}$ over 90% of globe

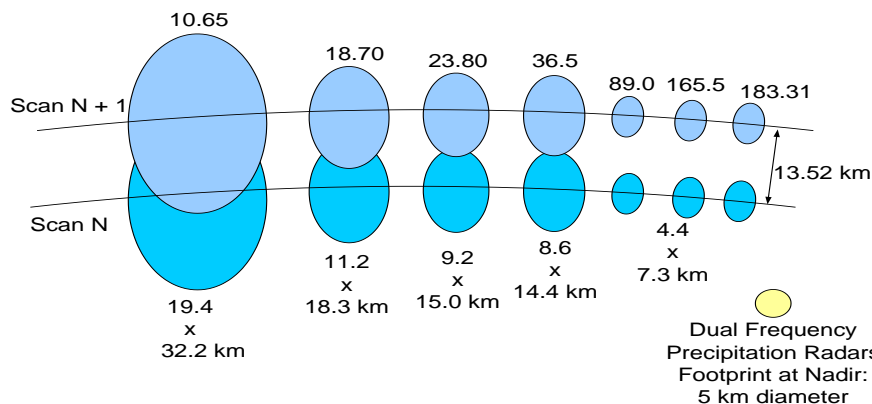


	Average Revisit Time (hr)				
Year	2013	2014	2015	2016	2017
Land					
Tropics	1.9	1.5	1.5	1.6	2.4
Extratropics	1.3	1.0	1.0	1.2	1.4
Globe	1.6	1.2	1.2	1.4	1.8
Ocean					
Tropics	3.2	2.6	2.6	2.6	4.9
Extratropics	3.3	2.6	2.6	2.6	3.4
Globe	3.2	2.6	2.6	2.6	4.2
Land and Ocean					
Tropics	2.8	2.3	2.3	2.3	4.2
Extratropics	2.6	2.1	2.1	2.1	2.7

1-2 hr revisit time over land with inclusion of sounders

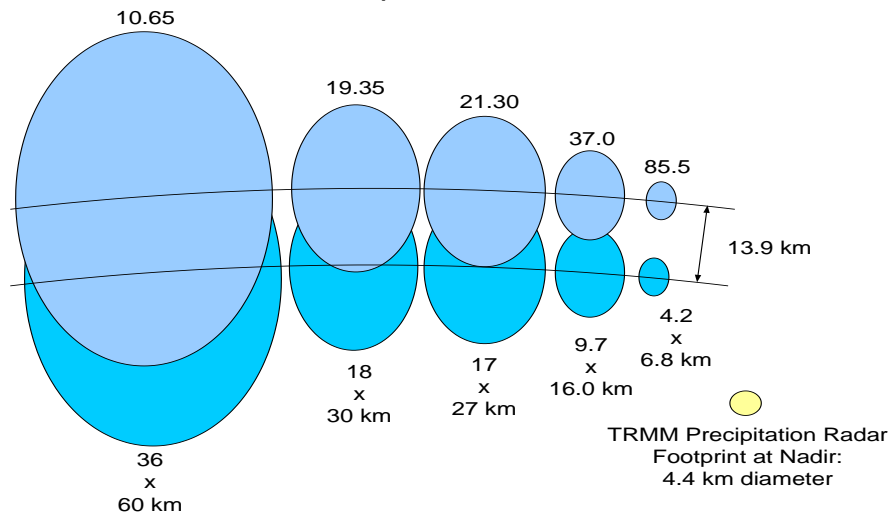


GPM Core Observatory / GMI at 407 km



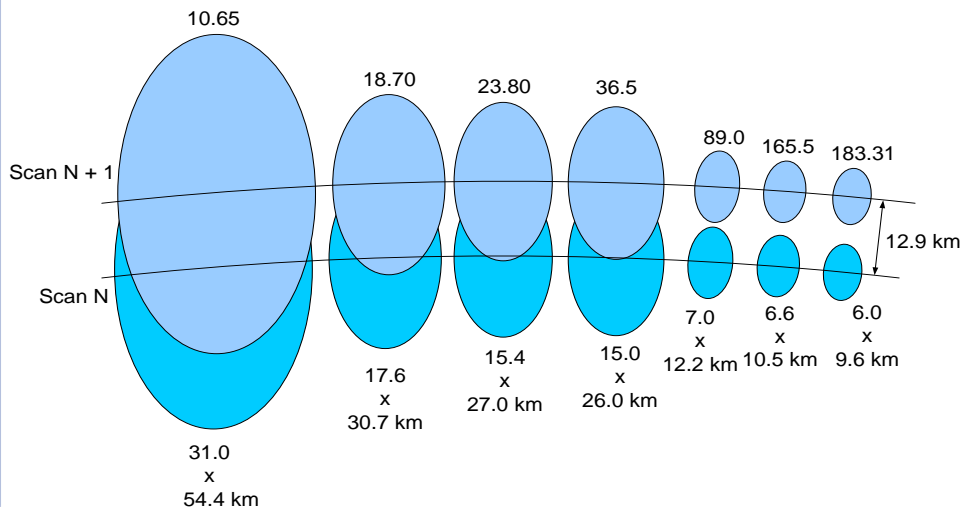
Key Parameters:
Off-Nadir Angle = 48.5 degrees
Scan Rate (TMI / GMI) = 31.6 rpm / 32.0 rpm

TRMM / TMI at 350 km



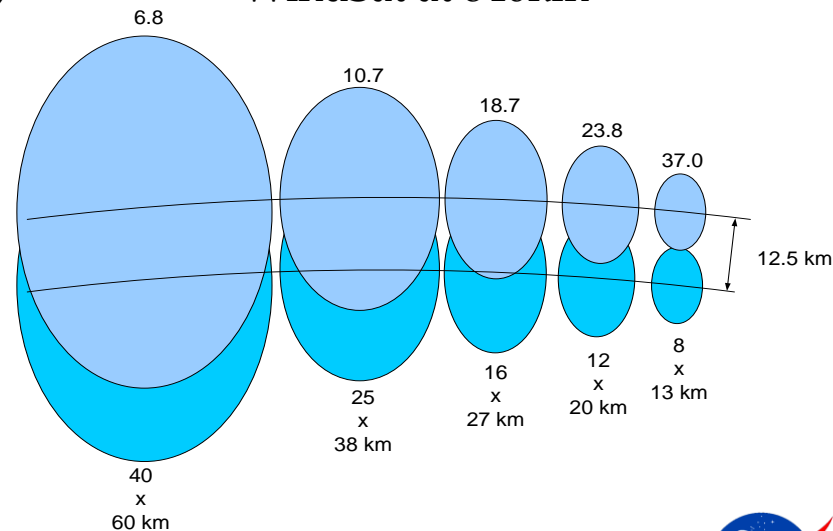
Scale: 10 km

GMI at 635 km (Deleted from Program Feb 2011)



Key Parameters:
Altitude: GMI 635 km, WindSat 840 km
Scan Rate: GMI 32.0 rpm, WindSat 31.6 rpm

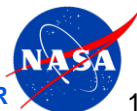
WindSat at 840km



Scale: 10 km



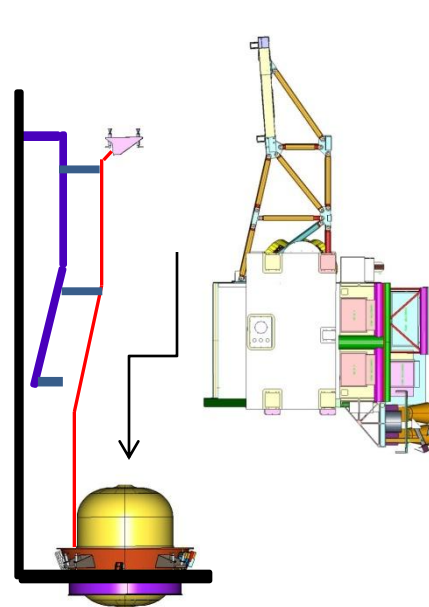
- **GPM Core Observatory at 400 Km & 65 degree inclination**
 - 65 Provides;
 - Cross calibration of all GPM constellation Radiometers
 - More inland coverage and higher latitude to cover snow and ice retrieval
 - Same altitude TRMM satellite 400 Km (launched in 97 with Ku band Radar and smaller Radiometer) to provide data continuity for Ku Band
 - TRMM at 35 degree inclination – covered mostly the tropics
- **65 degree inclination a none sun-sync orbit**
 - 180 degree Yaw maneuver required every 30 days to keep one side of the spacecraft (radiators) always pointed away from sun
 - GPM Core Observatory has front and rear thrusters to provide altitude maintenance in either orientation
 - Required one solar array at approximately 50 degree cant angle
- **Being at same altitude as Space Station (400 Km) requires;**
 - Careful orbit injection planning
 - Launch Vehicle collision avoidance; maneuver and lower the third stage altitude below 400 Km after spacecraft separation
 - Precise orbit maintenance maneuvers



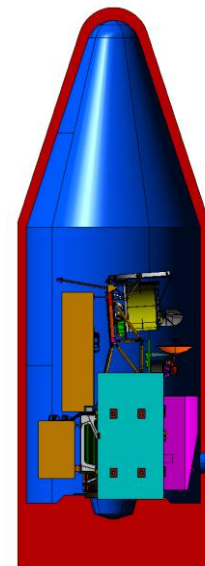
- **Require to meet 12 m² footprint in order have uncontrolled reentry**
 - Aluminum parts used to burn upon re-entry
 - Minimized the use of titanium
 - Only used titanium where material strength was critical
 - Key components designed to demise
 - Propulsion tank (holds 550 Kg of fuel) made out of aluminum with composite wrap
 - Propulsion Management Device (PMD) made out of aluminum
 - Reaction Wheels made out of Aluminum
 - Structure made out of aluminum and composite
- **At PDR (Nov 2008), most recent modeling applied a large penalty to small titanium fittings, therefore total observatory footprint exceeded 12 m² limit**
- **Following the PDR, spacecraft redesigned for controlled reentry at the end of mission life**
 - Higher performance thruster required to meet end of life requirement
 - Fuel allocation for reentry
 - Analysis for needed critical components to meet reliability numbers



- **Spacecraft bus designed to accommodate fully welded propulsion system integration**
 - To save time during Observatory Integration and provide flexibility welding is NOT allowed on spacecraft after avionics have been integrated
- **Designed to preclude interference between GMI (36.5 GHz) and DPR (Ka 35.5 GHz) instruments**
 - Filters on both instruments
 - “Blanking” capability for on-orbit mitigation if needed
- **Designed to preclude “jitter” between GMI rotation and solar array**
 - Fundamental frequency design constraints
 - GMI balancing
 - On-orbit mitigation for separating resonant frequencies by changing GMI spin rate



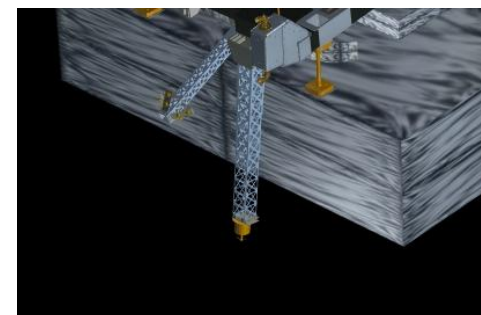
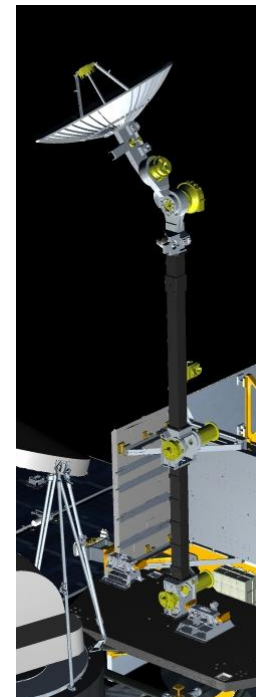
*Propulsion system
integration*



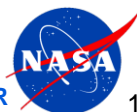
*HII-A
accommodation*



- **High Gain Antenna System to communicate with TDRSS for Commanding and down linking the Science and spacecraft data**
 - Continuous TDRSS link – high rate slewing from TDRSS to TDRSS
 - Continuous TDRSS link to Meet GMI real-time data requirement (hurricane monitoring)
 - High rate requires a comprehensive life test of the two axis gimbals
- **Two Omni antennas (Nadir and Zenith) as a back-up system and spacecraft commanding during contingency mode**
 - To command spacecraft during and anomaly (spacecraft tumbling)



- **GPM Core observatory will be shipped to Japan with C-5 aircraft**
 - Refueling in air to avoid landing
 - C-5 needs a long runway and very few commercial airports have long enough runway for C-5 to land
 - Will replace Air Force with NASA logo on the C-5
 - Can only land in Nagoya or Kagoshima airports
 - The only two airports with long enough runway for C-5 to land
 - Shipping container does NOT fit in C-17 aircraft
- **Will use barge to ship from Nagoya or Kagoshima to Tanegashima Island (south of Japan) – Tanegashima Space Center (H-IIA launch pad)**
 - Tanegashima Island airport runway not long enough for C-5

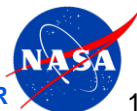


- **Programmatic**

- GPM Mission was “Confirmed” by NASA HQ December 2, 2009 to proceed with the implementation phase
 - Core Observatory Launch Readiness Date (LRD) July 2013
- Mission CDR successfully held Dec 14-17, 2009
- Low-Inclination Observatory (LIO) implementation via partnership
 - Successful HQ meeting with INPE (Brazilian Space Program) Oct 12, 2010 to discuss potential LIO partnership; LRD 2014/2015
 - NASA/AEB/INPE establishing joint working group for one-year study
 - Plan face-to-face meetings in early 2011



- **GMI Instrument (Delivery targeted for late September 2011)**
 - All Receiver Testing completed and meeting the NE Δ T requirements for all channels
 - Receiver Shelf System EMI and Thermal Vacuum testing completed
 - Instrument Bay Structure (IBS), Instrument Support Structure (ISS), Instrument Controller Assembly (ICA) and Spin Mechanism Assembly (SMA) have been integrated at Ball (see picture)
 - The SMA operation at 32 RPM verified
 - The ITT harness, Electronic Digital Controller (EDC) and Electronic Power Controller (EPC) have been mechanically and electrically integrated
 - ITT Receivers are only remaining hardware to be delivered
 - 36 GHz - Feb 8 ,10 GHz – Feb 17, 18/23 GHz – Mar 7, 183 GHz – Mar 7,166 GHz – Mar 22, 89 GHz – Mar 22
 - Key GMI near term milestones:
 - Complete instrument integration and initial performance test by the end of March
 - Pre-Environmental Review late April/early May



Spec.	Description	Units	Req.								
				PDR	PSR 7/08	PSR 12/08	CDR 6/09	PSR 11/09	PSR 03/10	PSR 05/10	PSR 9/10
TR3.1.4	10.65 NEDT	K	0.96	0.95	0.94	0.95	0.96	0.96	0.96	0.96	0.96
TR3.1.4	18.7 NEDT	K	0.84	0.83	0.82	0.88	0.81	0.82	0.82	0.82	0.82
TR3.1.4	23.8 NEDT	K	1.05	0.70	0.71	0.71	0.97	0.97	0.82	0.82	0.82
TR3.1.4	36.5 NEDT	K	0.65	0.61	0.54	0.53	0.54	0.54	0.56	0.56	0.56
TR3.1.4	89 NEDT	K	0.57	0.41	0.41	0.45	0.42	0.40	0.40	0.40	0.40
B.3.1.2	166 GHz NEDT	K	1.5	1.37	1.70	1.58	1.40	1.48	1.47	0.81	0.81
B.3.1.2	183 GHz NEDT	K	1.5	1.03	1.56	1.44	1.28	1.18	1.18	0.87	0.87
B.3.1.2	183 GHz NEDT	K	1.5	1.04	1.65	1.42	1.36	1.22	1.21	0.81	0.81
TR3.1.5.4	10.65 beam eff.	%	90	91.4	91.4	91.4	91.4	91.4	91.4	91.4	92.1
TR3.1.5.4/Derived	18.7 beam eff.	%	91	92.0	92.0	92.0	92.0	92.0	92.0	92.0	93.3
TR3.1.5.4/Derived	23.8 beam eff.	%	92	92.5	92.5	92.5	92.5	92.5	92.5	92.5	94.3
TR3.1.5.4	36.5 beam eff.	%	95	96.6	96.6	96.6	96.6	96.6	96.6	96.6	98.5
TR3.1.5.4/Derived	89 beam eff.	%	95	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
TR3.1.5.4	166 beam eff.	%	90	91.9	91.9	91.9	91.9	91.9	91.9	91.9	91.9
TR3.1.5.4	183+/-3 beam eff.	%	90	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7
TR3.1.5.4	183+/-8 beam eff.	%	90	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7
TR3.2.1.3/CPE	10.65 Calibration Unc	K	1.35	0.70	1.16	1.16	1.04	1.04	1.04	1.04	1.04
TR3.2.1.3/CPE	18.7 Calibration Unc	K	1.35	0.68	1.17	1.17	1.08	1.08	1.08	1.08	1.08
TR3.2.1.3/CPE	23.8 Calibration Unc	K	1.35	0.62	1.16	1.16	1.26	1.26	1.26	1.26	1.26
TR3.2.1.3/CPE	36.5 Calibration Unc	K	1.35	0.56	1.14	1.14	1.20	1.20	1.20	1.20	1.20
TR3.2.1.3/CPE	89.0 Calibration Unc	K	1.35	0.57	1.14	1.14	1.19	1.19	1.19	1.19	1.19
TR3.2.1.3	166 Calibration Unc	K	1.5	0.75	1.31	1.31	1.20	1.20	1.20	1.20	1.20
TR3.2.1.3	183+/-3 Calibration Unc	K	1.5	0.74	1.34	1.34	1.20	1.20	1.20	1.20	1.20
TR3.2.1.3	183+/-8 Calibration Unc	K	1.5	0.75	1.34	1.34	1.20	1.20	1.20	1.20	1.20

- **NEDT performance**

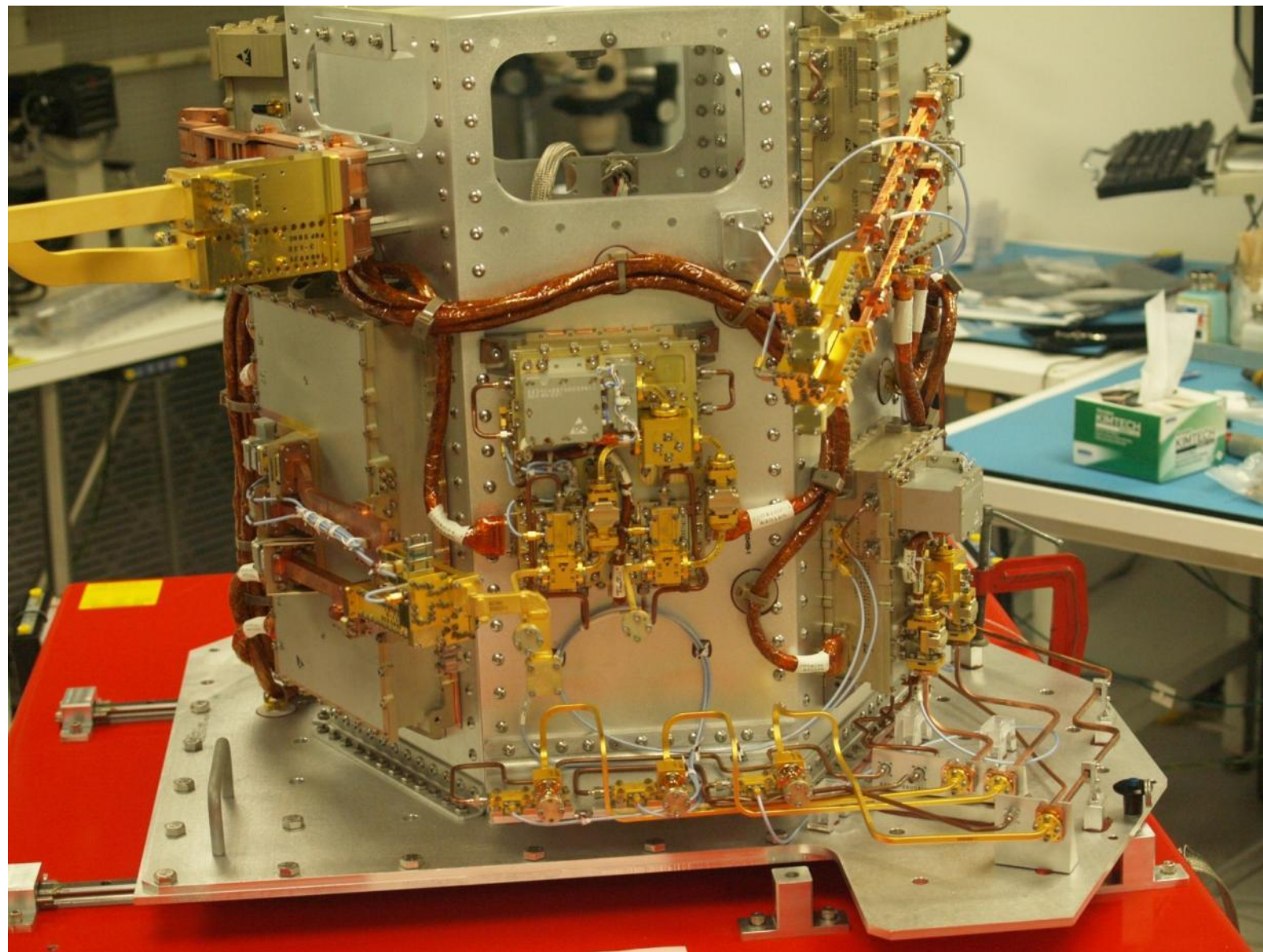
- All frequencies based on flight performance

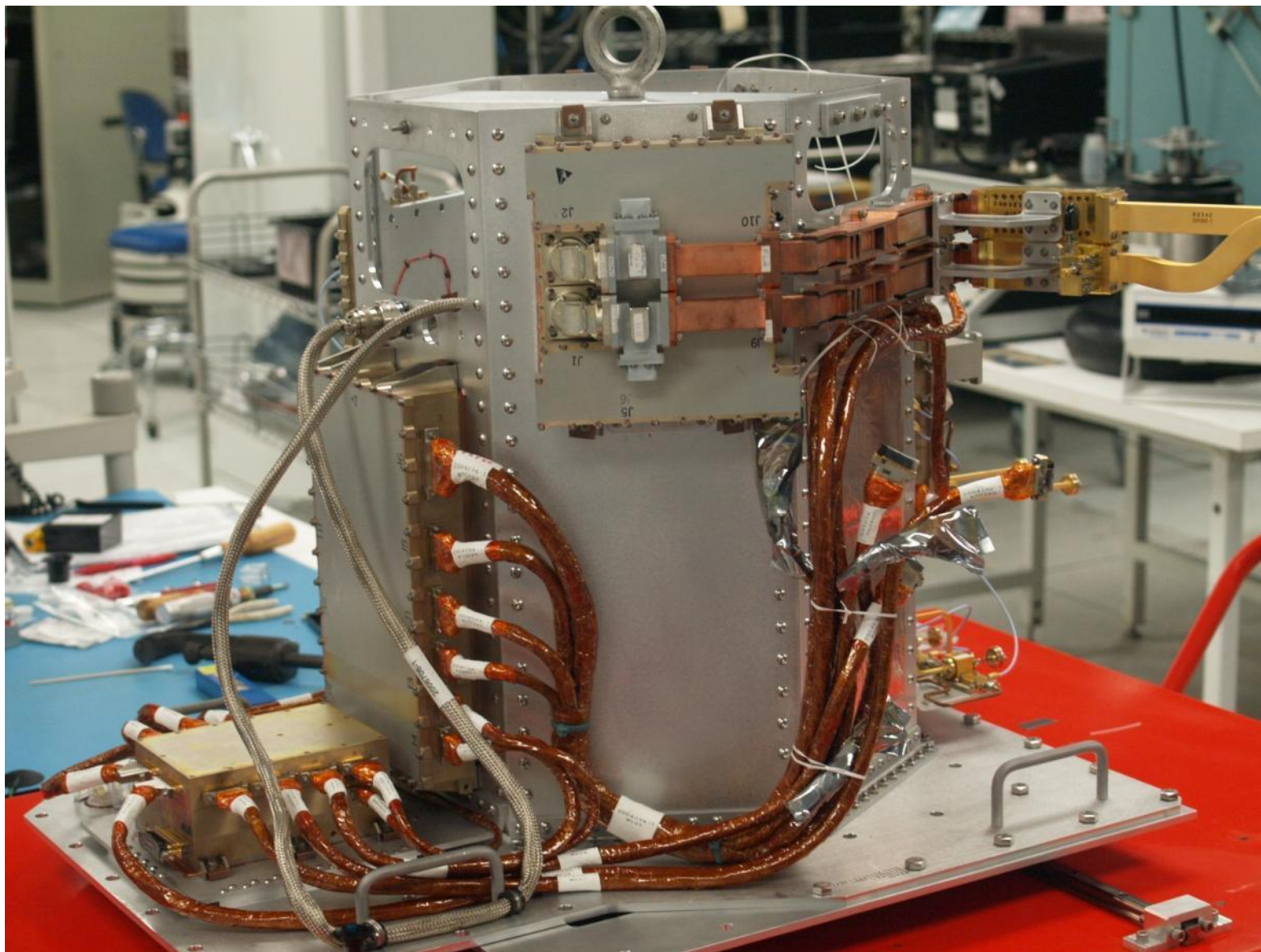
- **Beam efficiency**

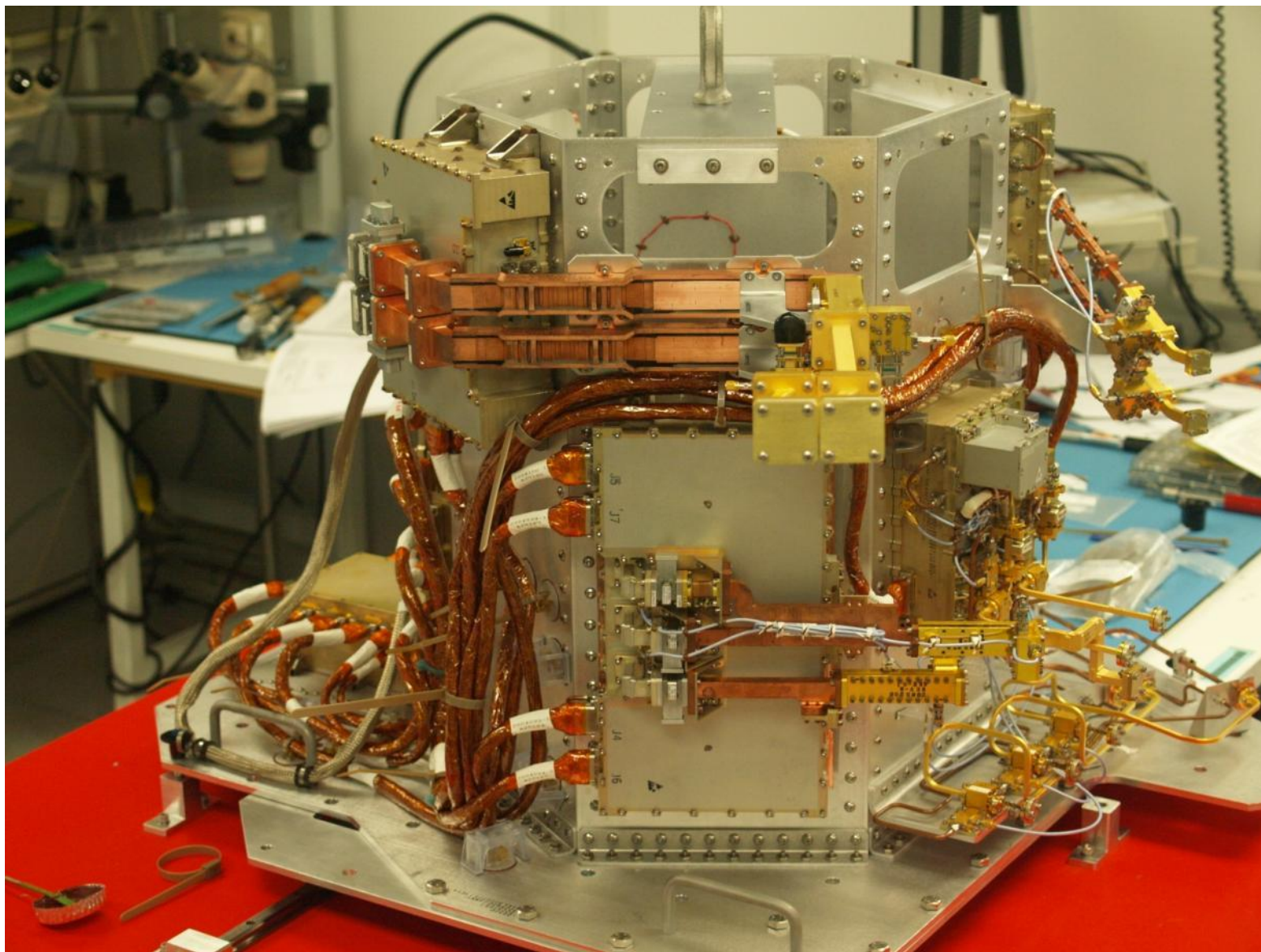
- All frequencies based on measured flight data using flight feedhorns and Main Reflector

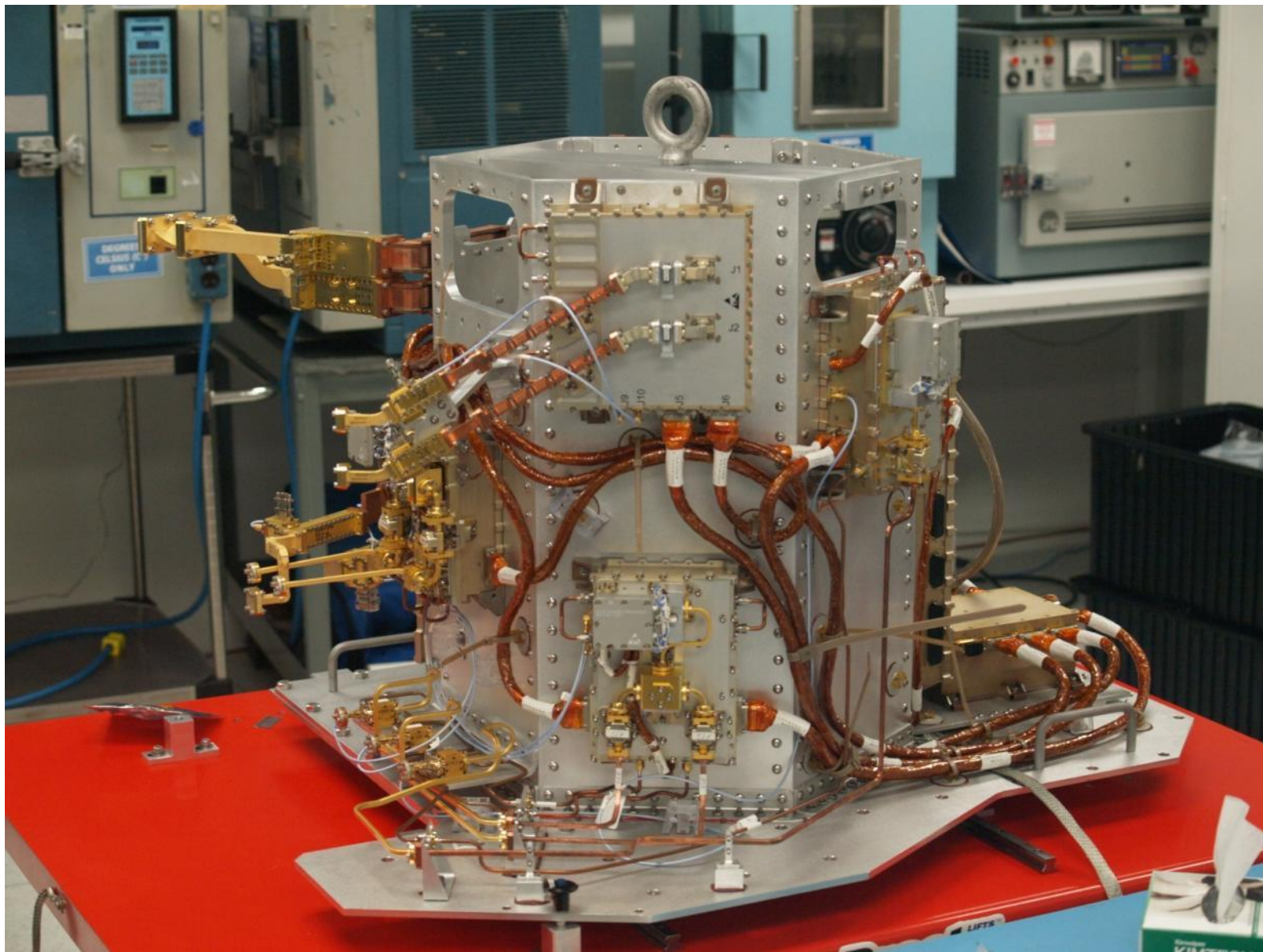








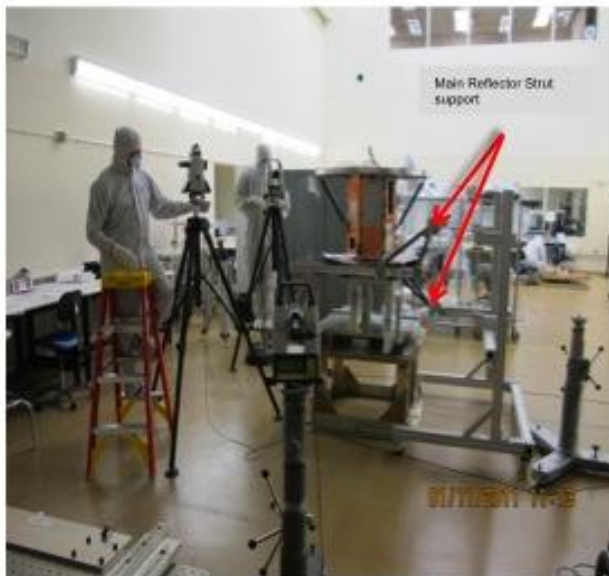


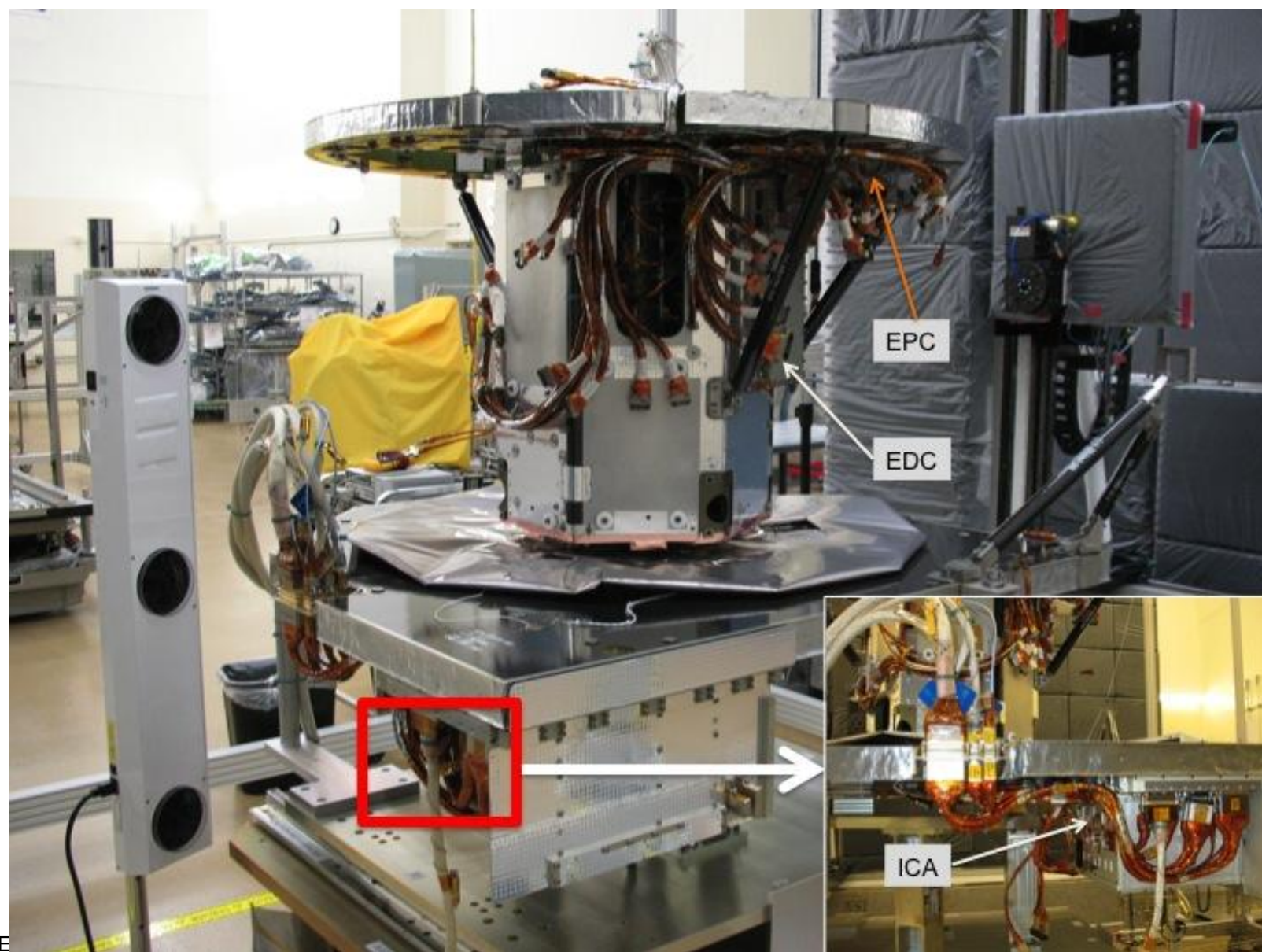


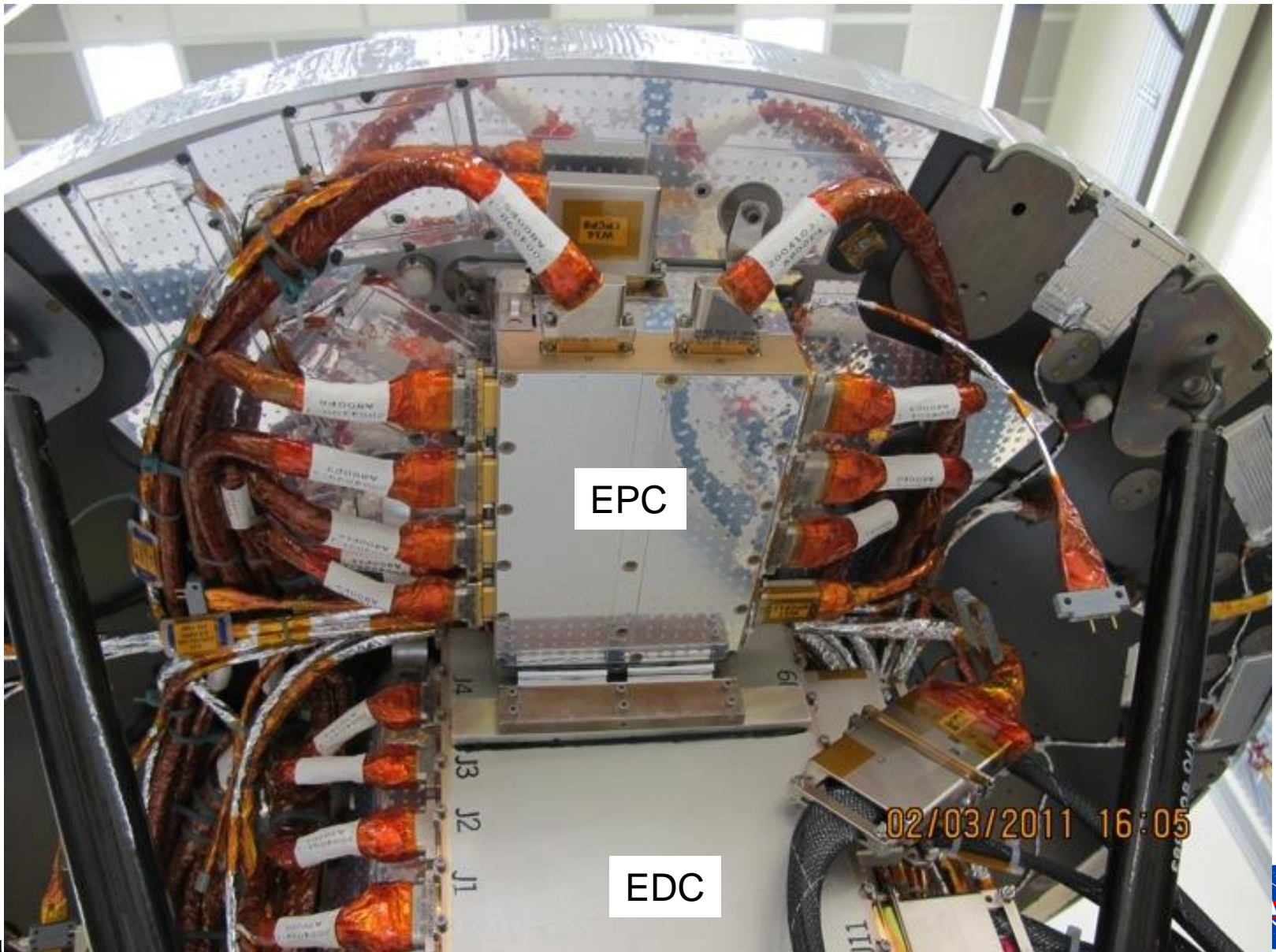




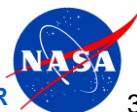






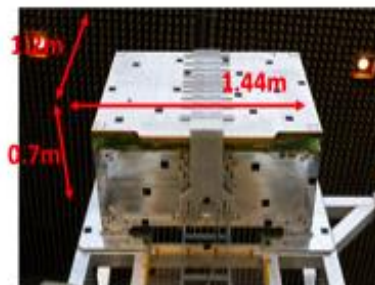


- **Dual Precipitation Radar Instrument (JAXA/NTSpace) – Delivery date targeted for early July 2011**
 - KuPR/KaPR testing at Tsukuba Space Center (JAXA) is proceeding 7 days/week
 - Pre-Environmental Review held Jan 13-14, 2011
 - Issue of thermal vacuum testing profile (powering on instrument during thermal transitions and soak time) being worked between JAXA and NASA
 - Follow-up videocon Feb. 2 addressed KaPR initial performance test, T/V test profile, and other issues from PER; Additional follow-up Feb. 15
 - KaPR delivery date may be impacted due to power-on transition requirement during T/V (suggested by NASA during PER)
 - KuPR completed vibration testing and thermal vacuum testing has begun
 - KaPR electrical performance test completed and preparing for acoustic test
 - Key DPR near term milestones:
 - Complete KuPR T/V – Feb 2011
 - Complete KaPR T/V – Apr 2011



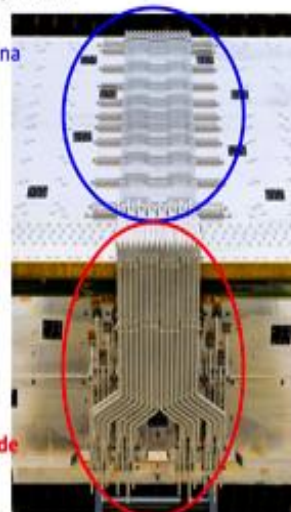
KaPR EM consists of 32 elements of waveguide slot array antenna.

waveguide slot array antenna



The length of waveguide between the transmitter unit and the antenna element is the same for all channels.

waveguide



DPR photos provided by JAXA



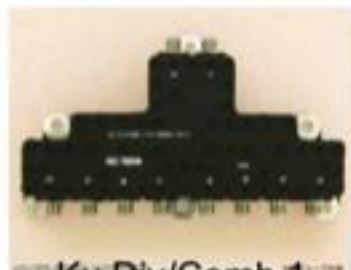
Ku T/R unit



Ka T/R unit



Interface box



Ku Div/Comb 1

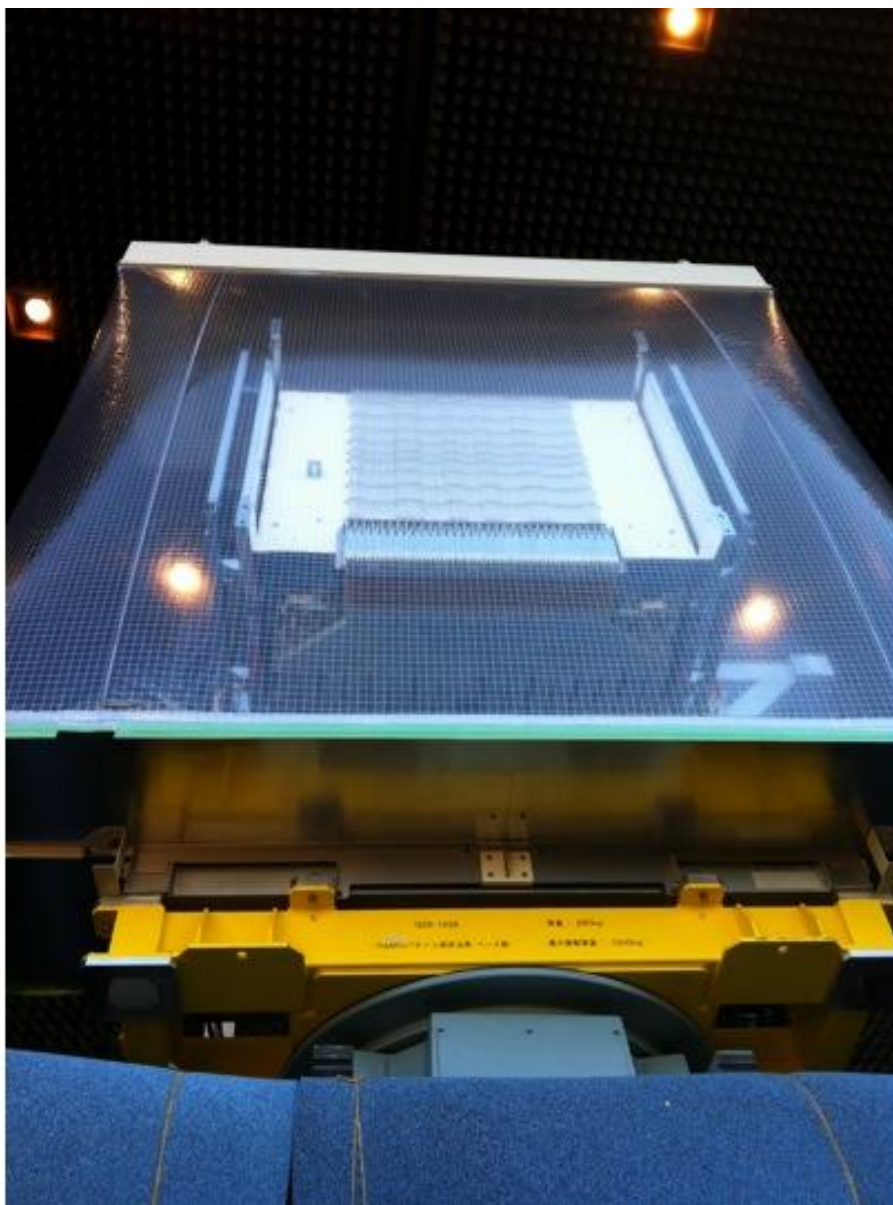


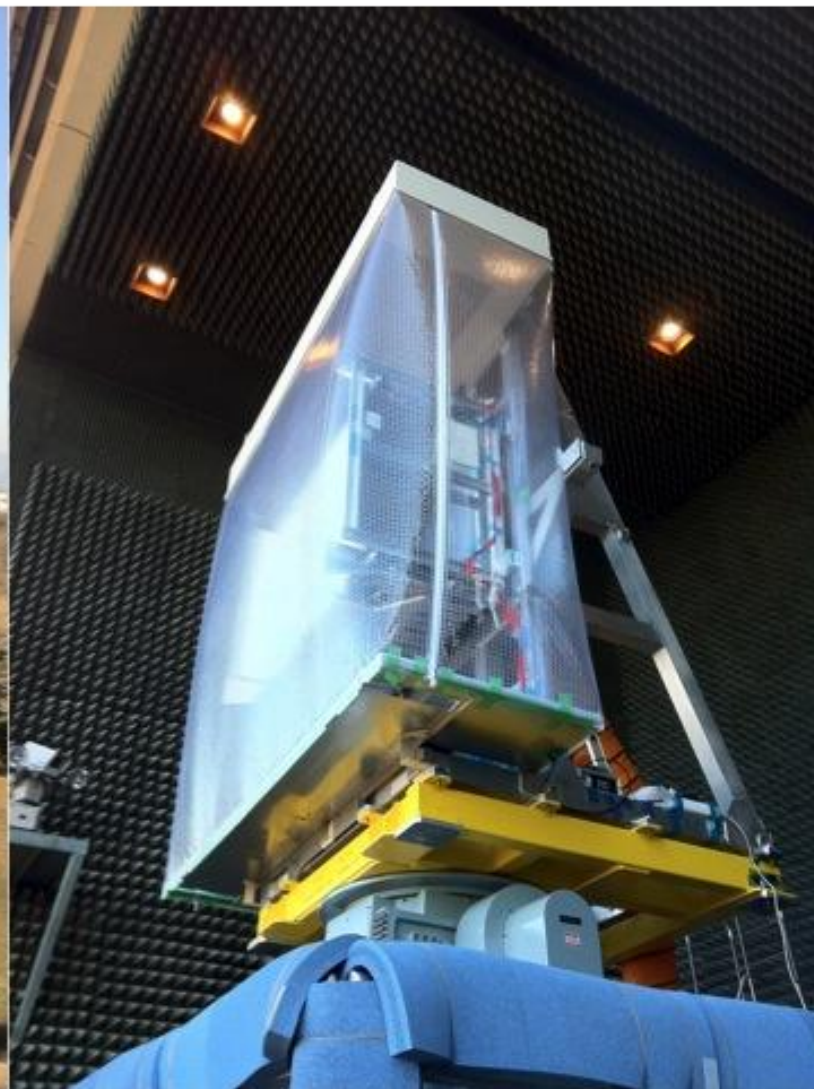
Ka Div/Comb 1



Ku RX BPF







- **Core Observatory**

- Thermal control system integration (avionics heat pipes, TCS harness) with flight lower bus structure complete
 - Completed flight Lower Bus Structure -Z avionics panel installation
- Flight harness bake-out complete and integrated onto Lower Bus Structure
- Qual Structure assembly completed mass properties; next steps are Modal Survey Test and Strength Test (on centrifuge)
- Avionics flight board manufacture at NG and BAE continues (C&DH: 3 SBC, 2 DSB, 2 SLVPC, 2 ULVPC, 2 DIO; PSE: 2 HM; GPS: 2 PCC delivered). PSE backplane solder fill issues resolved with three re-works and one white-wire.
- DiRWA anomaly experienced during component T/V testing. Potential root cause identified; modifying ETU with proposed design change
 - I&T flow reworked to accommodate late delivery
- SADDs qual/backup flight boom and panel in final assembly
- Flight thrusters and pressure transducers delivered
- FLATSAT ETU testing in progress: C&DH #1, PSE, PIE, Star Tracker, IRU

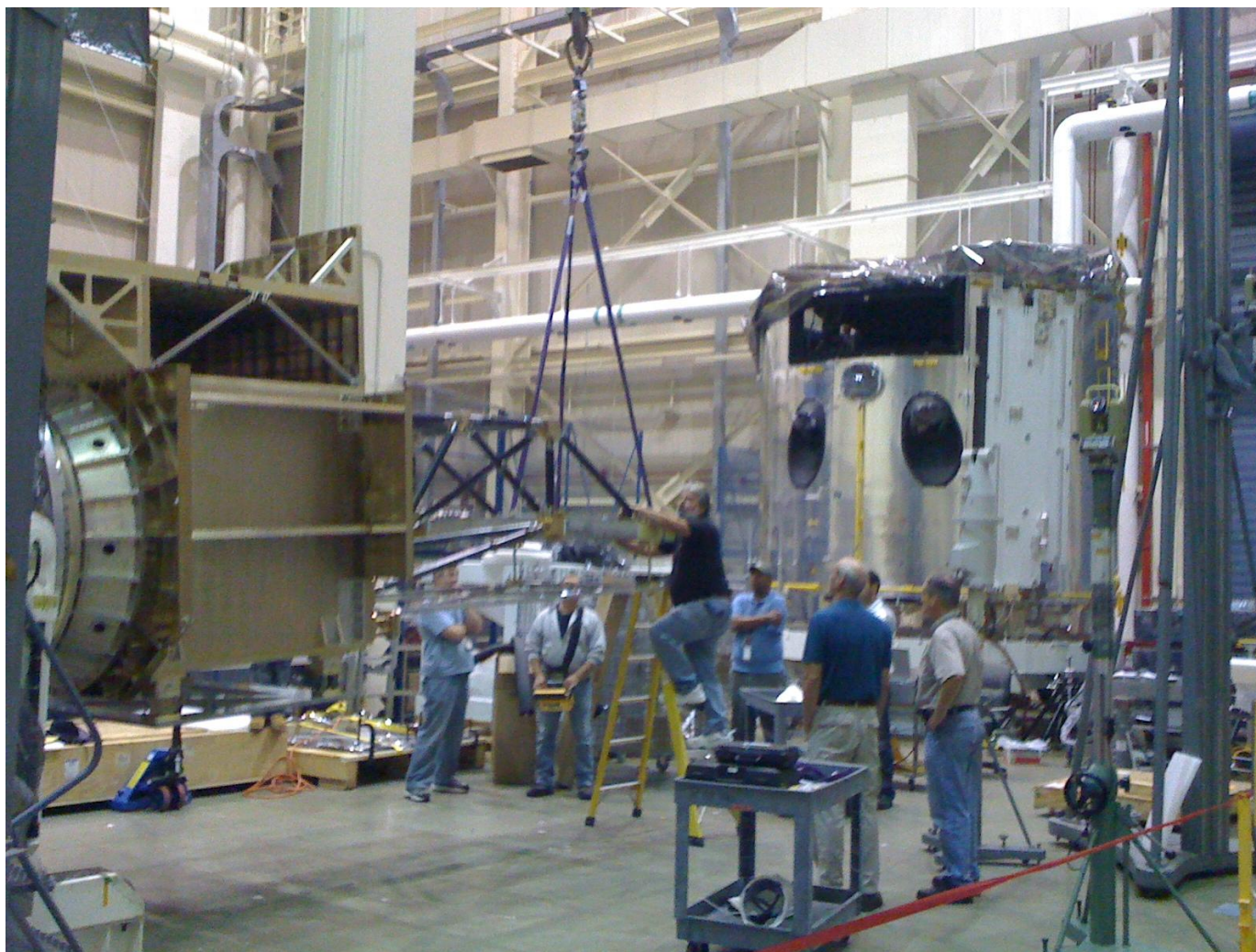




Flight Structure assembled



DPR alignment test completed



GMI alignment test completed



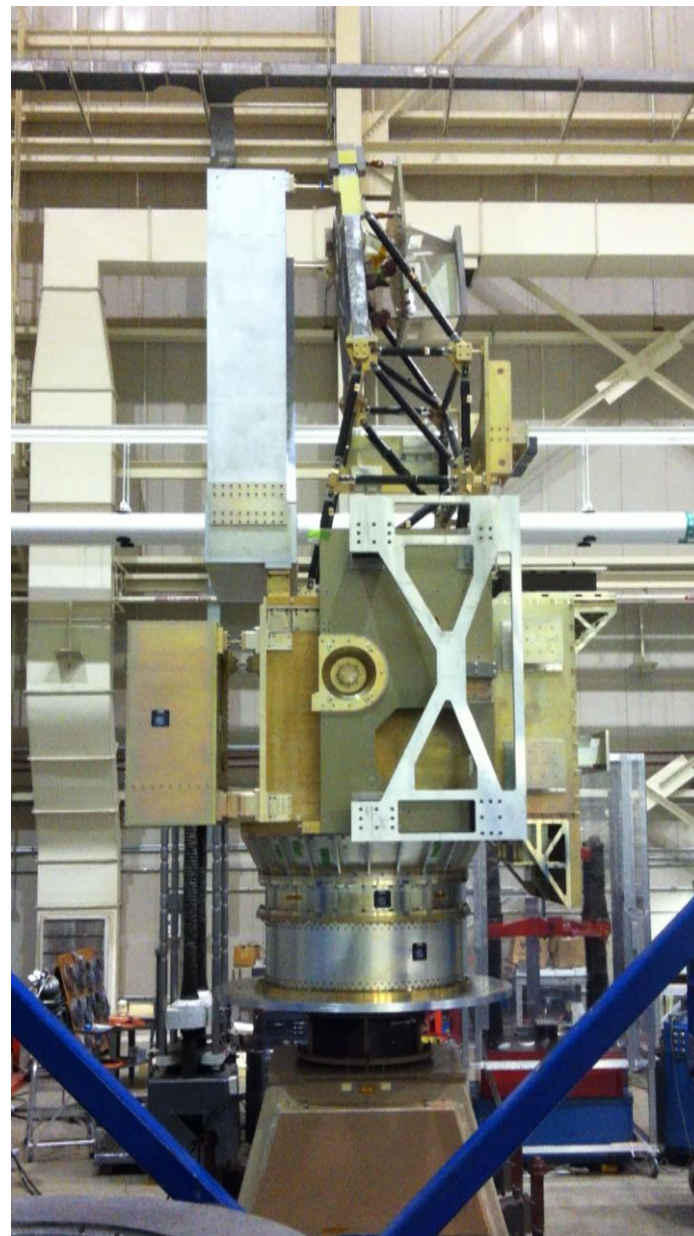
Preparing GPM Flight Lower Bus Structure for
Harness Installation



GPM Qualification Structure



- **Measuring moment of inertia – rotating back and forth**



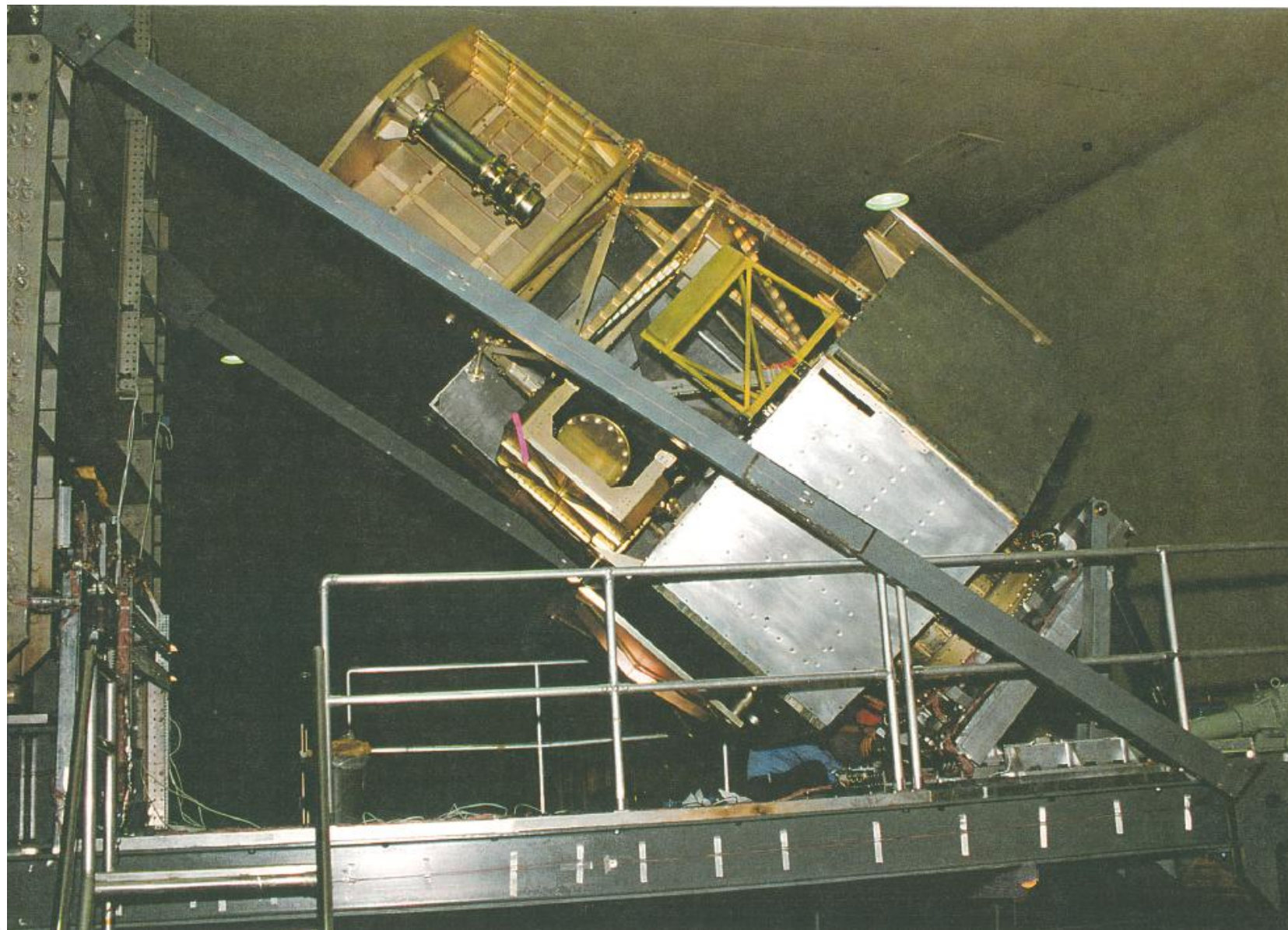
- **Measuring Center of Gravity of the Core Observatory – rotating at 5-6 revolution per minute**





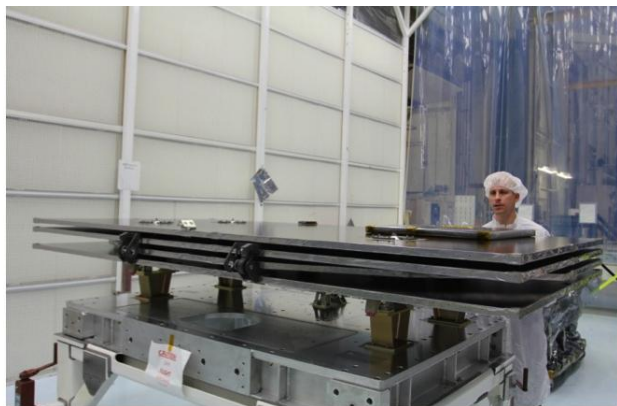
GPM Centrifuge Test Configuration (similar to TRMM shown)



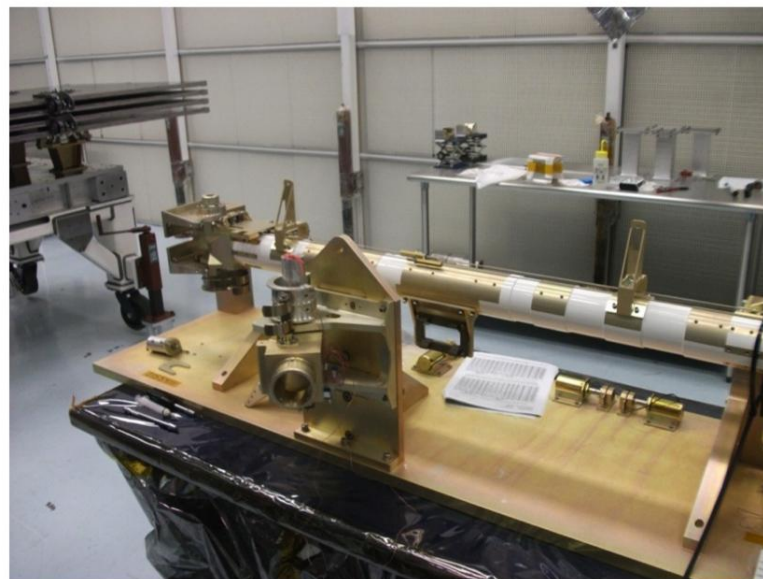


TRMM Centrifuge Test – Configuration 1

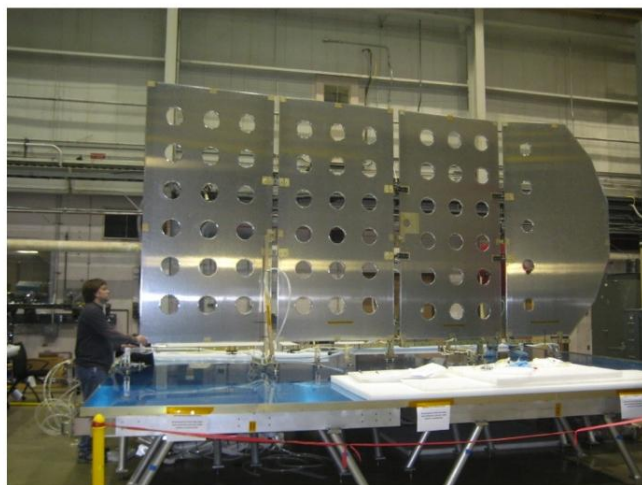




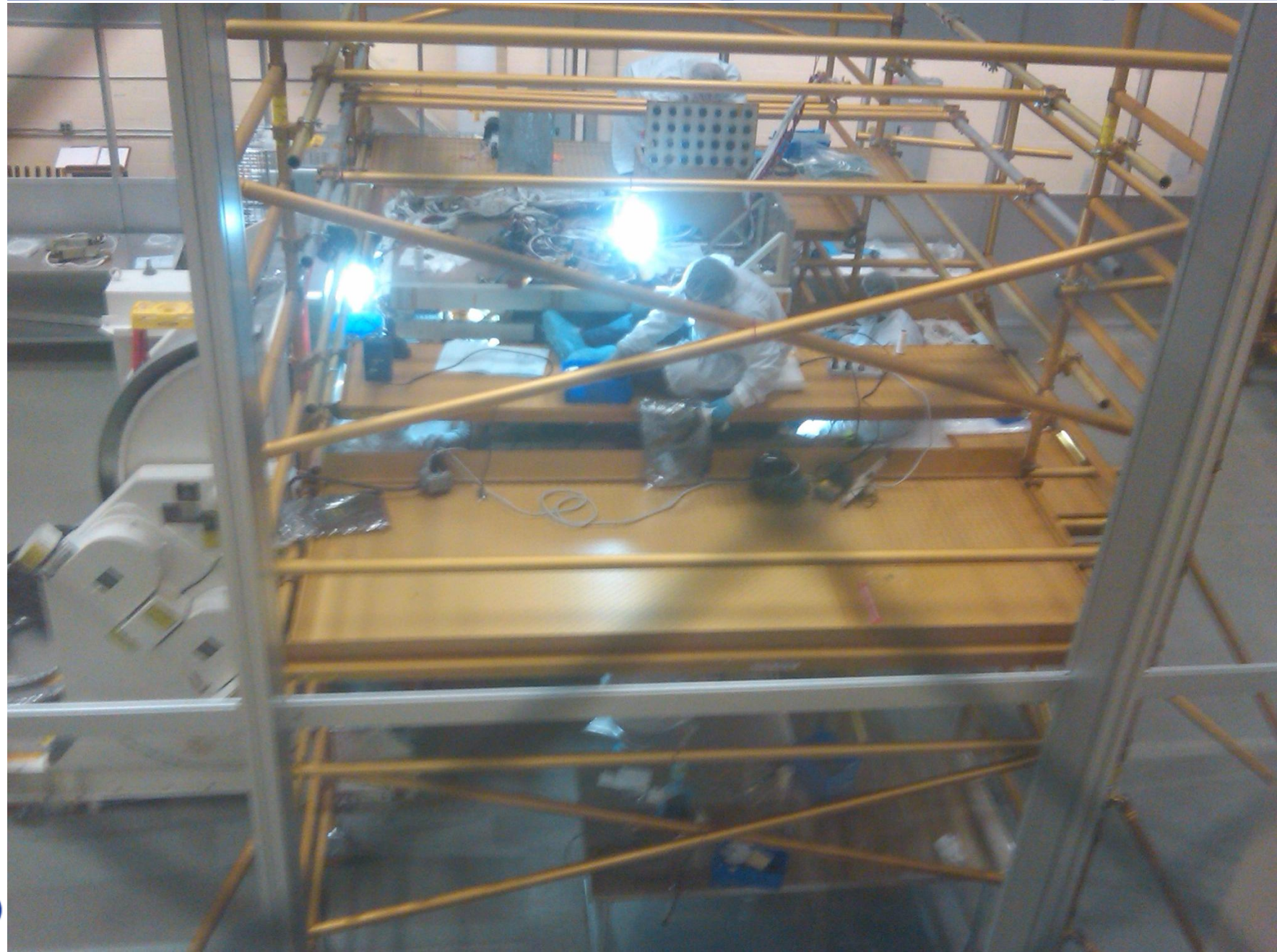
Panel in Stow Configuration



SADDS Qual Boom Assembly



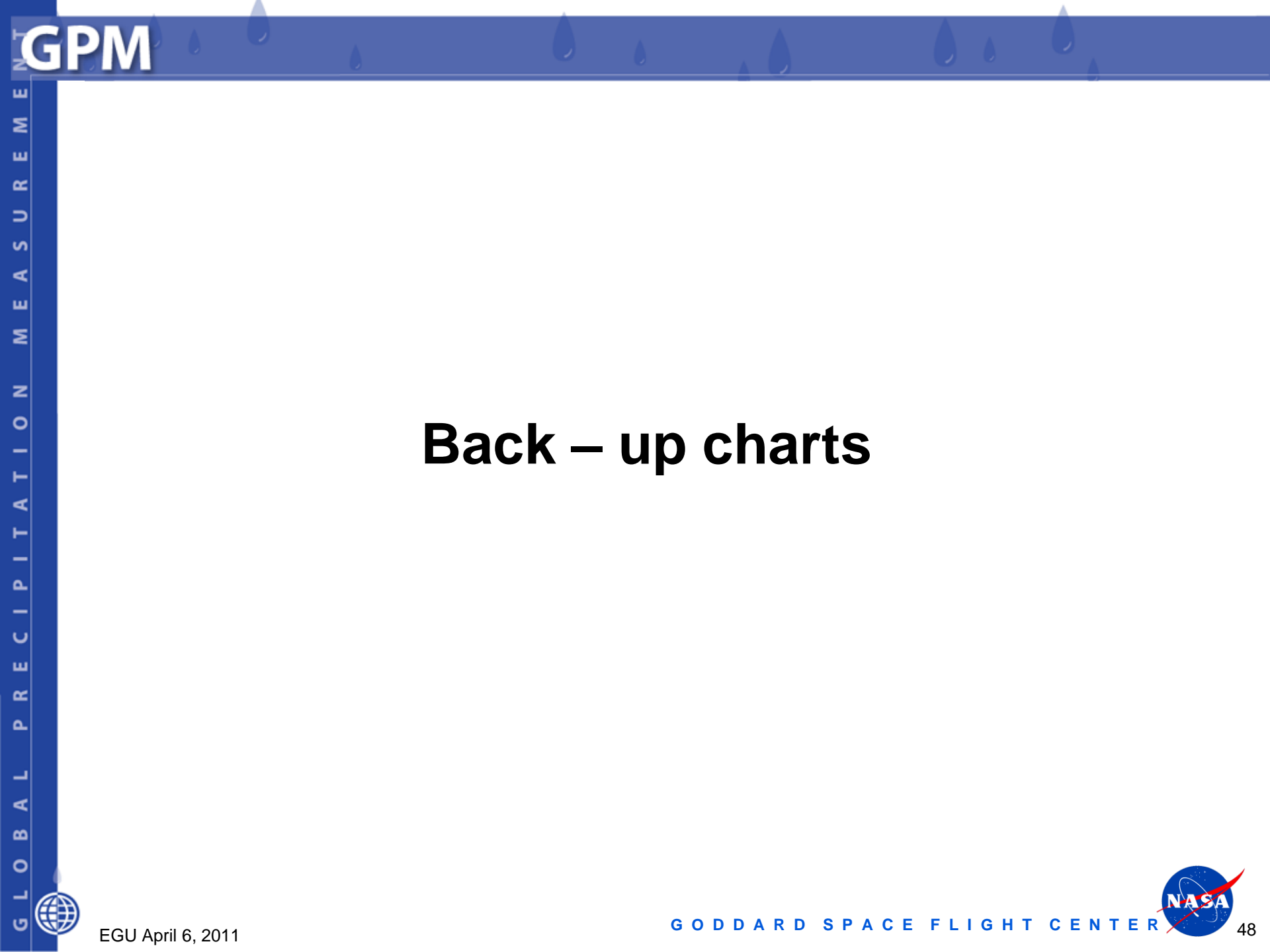
Deployment Testing GSE (with panel model)



- **Integration kick-off November 2010**
 - Heat Pipe and Harness Integration on flight structure
 - Structure Qualification as a parallel activity
- **Avionics and Propulsion Module integration Feb – July 2011**
 - Solar Array and deployment Test and Qualifications in parallel
- **Instrument Integration August – October 2011**
- **Core Observatory Environmental Testing Nov 2011 – Jan 2013**
 - EMI/EMC Test
 - Vibration Test
 - Acoustic Test
 - Thermal Vacuum Testing
 - Post Environmental Deployments
- **Solar Array Installation and mass properties Feb 2013**
 - Measuring mass and center of gravity
- **Ship to Launch site March/April 2013**
- **Launch site preparation activities April – June 2013**
 - Launch site testing of spacecraft and fueling
- **Launch vehicle fairing encapsulation and final test June/July 2013**
- **Launch July 2013**



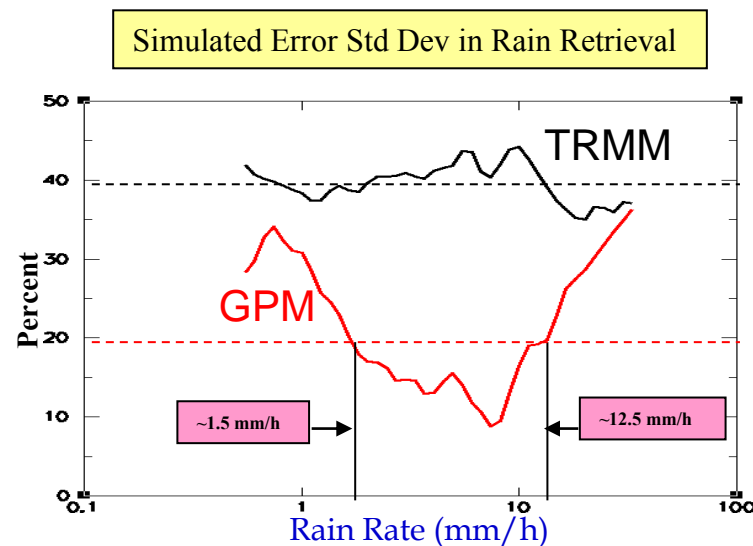
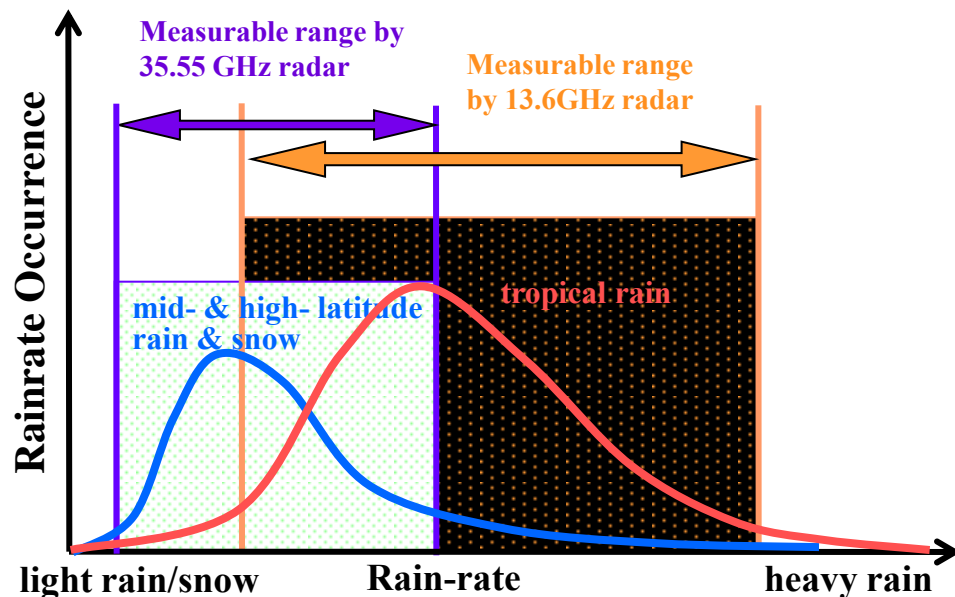




Back – up charts

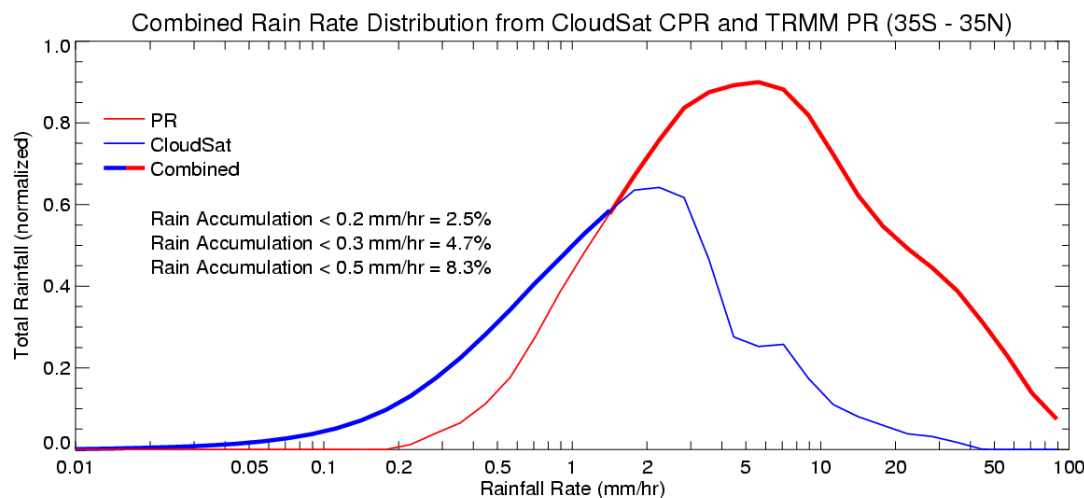


JAXA/NICT Dual-Frequency Precipitation Radar



Ku-band misses ~10% of the total tropical rain.

With the Ka-band, DPR will capture 97% of the total rain volume.



Product Level	Description	Coverage
Level 1B GMI, GMI-2 Level 1C GMI, GMI-2 <i>Latency ~ 1 hour</i>	Geolocated Brightness Temperature and intercalibrated brightness temperature	Swath, instrument field of view (IFOV)
Level 1B DPR	Geolocated, calibrated radar powers	Swath, IFOV (produced at JAXA)
Level 1C, partner radiometers	Intercalibrated brightness temperatures	Swath, IFOV
Level 2 GMI, GMI2 <i>Latency ~1 hour</i>	Radar enhanced (RE) precipitation retrievals	Swath, IFOV
Level 2 partner radiometers	RE precipitation retrievals from 1C	Swath, IFOV
Level 2 DPR <i>Latency ~3 hours</i>	Reflectivities, Sigma Zero, Characterization, DSD, Precipitation with vertical structure	Swath, IFOV (Ku, Ka, combined Ku/Ka)
Level 2 combined GMI/DPR <i>Latency ~3 hours</i>	Precipitation	Swath, IFOV (initially at DPR Ku swath and then at GMI swath)
Level 3 Latent Heating (GMI, DPR, Combined)	Latent Heating and associated related parameters	0.1 x 0.1 monthly grid
Level 3 Instrument Accumulations	GMI, partner radiometers, combined and DPR	0.1 x 0.1 monthly grid
Level 3 Merged Product	Merger of GMI, partner radiometer, and IR	0.1 x 0.1 hourly grid
Level 4 Products	Model assimilated data	Fine temporal and spatial scale TBD



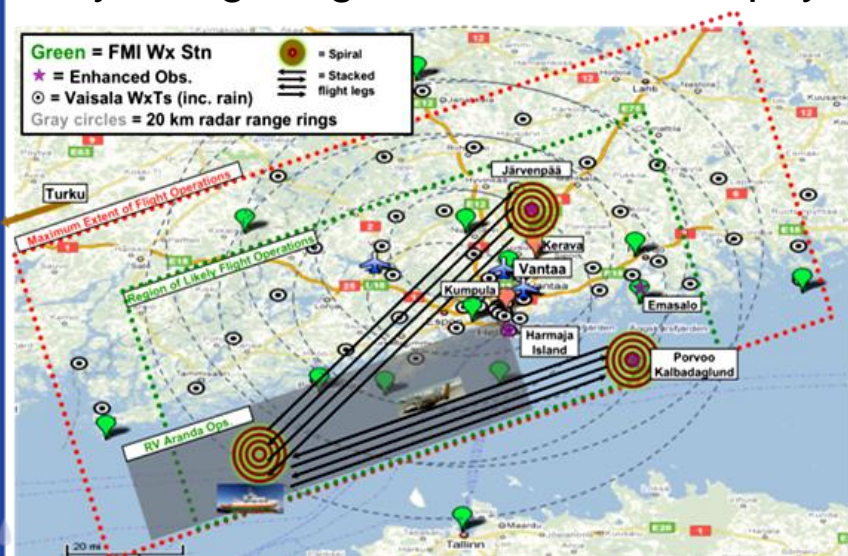
Target: Light rain in cold low altitude melting layer environment

GV Science:

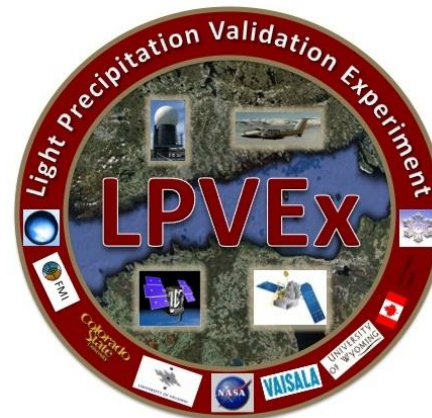
- Quantify column DSD/precip variability over inland, coastal, sea regimes
- Melting layer physics coupled to water below and ice above
- Reconstructed Ka-Ku band (DPR) data for DFR algorithm testing
- Observationally-validated model databases for radiometer algorithms

Approach:

- Heavily instrument surface sites + 1 Ship under radar/aircraft/satellite coverage at Järvenpää (*inland*), Harmaja (*Island*), Emasalo (*coast*), and R/V Aranda (*sea*)
- 3 Dual-pol radars, 6-8 disdrometers/4-MRRs/ADMIRARI radiometer/3 POSS U. Wyoming King Air Airborne microphysics + W-band radar

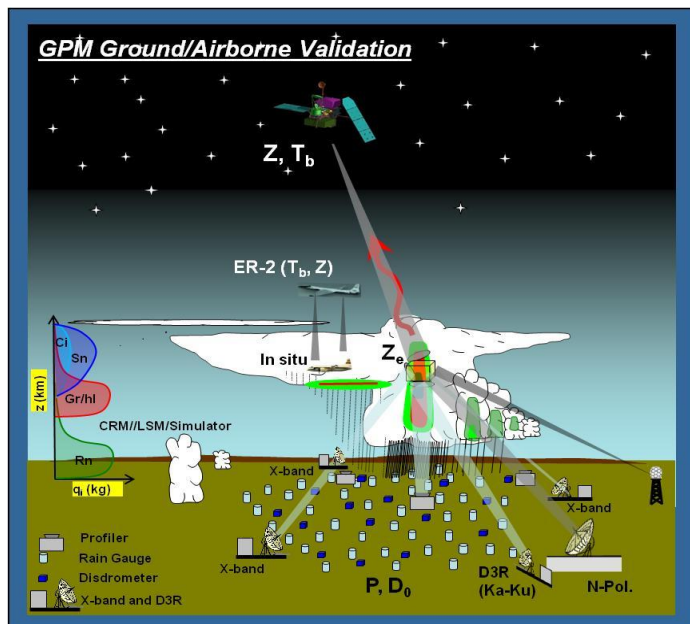


Helsinki-Testbed & Gulf of Finland



Target: Mid-latitude convective and stratiform rainfall over land

Location: DOE-ASR Central Facility, Oklahoma



GV Science Priorities

1. Coordinated Airborne [high altitude/in situ]

- High altitude Ka/Ku-band radar, multi-freq. radiometer with in-situ ice microphysics
- Pre/post storm surface properties

2. 3-D Mapping of *hydrometeor distribution/type*

- Unified framework for retrieving 3-D DSD
- Sub pixel scale DSD variability
- Cross validation/comparison of multi-frequency (Ka-Ku) and dual-pol. retrievals

3. Satellite *simulator models (CRM/LSM/RT)*

- High quality sounding-based forcing data
- Microphysical and kinematic validation.
- Land surface impacts

Confirmed Instruments:

- Aircraft: ER-2, UND Citation (microphysics)
- Radars: NPOL, D3R, DOE X-band(s), C-band, Ka/W, S/UHF profiler
- Surface: Dense disdrometer/gauge net. ASR surface met, radiometer, flux and, aerosol instruments
- Soundings: ASR array 6 – 8 launches/day

Status: Pre-field deployment sampling and logistics planning

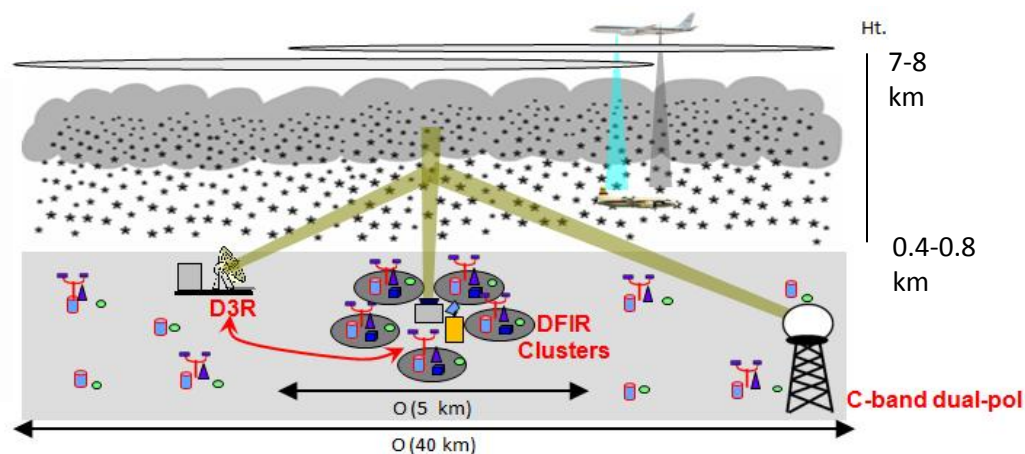
Target: Snowfall retrieval algorithms

GV Science

1. Radiometer/DPR Snowfall measurement sensitivities to snow type, rate, surface and tropospheric characteristics
2. Physics of snowfall in the column and relation to extinction characteristics
3. Model databases for forward modeling and retrieval development.

Approach

- Network observations of SWE and PSD
- In-situ and high-altitude airborne sampling
- Ground-based radar/profiling components
- Soundings for column T and Water Vapor



Status: Planning phase

Site chosen: Environment Canada CARE site in Ontario, Canada

Instruments planned: DC-8 (Ka-Ku band radar, CoSMIR radiometer), microphysics aircraft (TBD), D3R Ka-Ku radar, C-band dual-pol radar, numerous snow-gauge/disdrometer clusters, profiling radars at S/UHF, X, K, and W-bands.

